Electrical World and Engineer

THE CONSOLIDATION OF "THE ELECTRICAL WORLD" AND "ELECTRICAL ENGINEER."

VOL. XLIII. NEW YORK, SATURDAY, FEBRUARY 6, 1904. No. 6.

ELECTRICAL WORLD AND ENGINEER.

Published weekly by the

McGRAW PUBLISHING CO.

114 LIBERTY STREET, NEW YORK.

TELEPHONE CALL: 7605 CORTLANDT. CABLE ADDRESS: ELECTRICAL, NEW YORK.

EDITED BY T. C. MARTIN AND W. D. WEAVER.

CHICAGO OFFICE - - - - - - 1139 Monadnock Block.
PHILADELPHIA OFFICE - - - - - - 929 Chestnut Street.
EUROPEAN OFFICE, Hastings House, Norfolk St., Strand, London, Eng.

NOTICE TO READERS

WHO ARE NOT SUBSCRIBERS.

ELECTRICAL WORLD AND ENGINEER is not returnable from the newsdealer. If you desire to purchase the paper from a dealer it will be to your advantage to notify him that you will want it, in order to insure his having a copy for you. If you wish to receive the paper regularly, please send in your subscription so that we can mail it to you direct.

Single copies are 10 cents each. The 52 copies for the entire year cost $3.00 in advance. Please send remittance with your subscription order.

ELECTRICAL WORLD AND ENGINEER.

NOTICE TO ADVERTISERS.

Change in advertisements intended for a particular issue should reach the office of ELECTRICAL WORLD AND ENGINEER by 10 A. M. MONDAY of the week of issue. New advertisements can be received up to noon of Tuesday of the week of issue.

The first issue of each month is an export issue, having an extraordinarily large foreign circulation in addition to the regular domestic and foreign circulation of this paper.

TERMS OF SUBSCRIPTION.

United States, Canada or Mexico - - - - - -	Per year, $3.00
Foreign Countries, within the Postal Union - - - - - -	6.00
Great Britain and Ireland - - - - - - - - -	25 shillings
Germany - - - - - - - - - - - - -	25 marks
France - - - - - - - - - - - - -	31 francs
Single copies - - - - - - - - - - - - -	.10

Remittances for foreign subscriptions may be made through our European office. In requesting your address changed give OLD as well as new address.

Copyright, 1904, by McGRAW PUBLISHING CO.

Entered as second-class mail matter at the New York Post Office.

NEW YORK, SATURDAY, FEBRUARY 6, 1904.

CONTENTS.

Editorial 253
The Annual Dinner of the American Institute of Electrical Engineers .. 256
A Striking Tesla Manifesto 256
Three-Wire Direct-Current Railway System 257
Legal Conditions of Co-operative Telephony 259
On the Wave Length of Free Vibrations in Antennae and Closed Oscillating Circuits. By Dr. James E. Ives 260
The Measurement of Distributed Leakage on Transmission Lines. By Frank F. Fowle 262
Elihu Thomson on Aeroplanes 265
Speed-Torque Characteristics of the Single-Phase Repulsion Motor 266
The Repulsion Type of Alternating Current Motor 268
Women in the German Telegraph-Telephone Service 271
Canadian Electrothermic Commission 271
New Telephone Patents 272
Wilkinsburg Electric Club 273
Recent Electrochemical Developments 274
Radium in Medicinal Springs 274
January Meeting of the American Institute of Electrical Engineers .. 275
When and How Incandescent Lamps are Used. By Mortimer Norden .. 276
Statistics of Export Trade 276
Vapor Tube Telephone Repeater 277
Current News and Notes 277
LETTERS TO THE EDITORS:
Theories in Wireless Telegraphy. By J. E. Taylor 278
Cannon Ball Trolley Cars. By L. S. Levy 278
Digest of Current Electrical Literature 279
New Books 282
Crompton Potentiometer 283
A New English Storage Battery 284
The Allis-Chalmers Nurnberg Gas Engine 285
The Heany Arc Lamp 286
Telephone "Express" Switchboard 286
Improvements in Sign Flashers 287
Metal Melting Furnace 287
Steel Frame Generators and Motors 287
Attaching Plug and Socket 288
News of the Week 289

THE DINNER AND THE LAMP.

It has been a felicitous idea to associate this year the annual dinner of the American Institute of Electrical Engineers with the twenty-fifth anniversary of the practical perfection and successful introduction of the incandescent lamp, and it was also a happy thought to associate the event next week with the birthday of Mr. Edison, who more than any other man is to be credited with that great accomplishment. The association of the annual dinner with some particular event in electrical history and achievement is, after all, an excellent plan, and we should be glad to see it realized from year to year. This has been a great electrical age and it will be a long time before the Institute runs out of worthy men and events to celebrate.

It seems but yesterday—especially to those of us who have been connected with this utilization of the incandescent lamp—that it was placed in the hands of the public, yet so swift has been its advance and its universal acceptance that already to-day, as compared with electricity, we find gas in the second place in this country as an illuminant. That alone tells the story of the need that existed for such a light and the fitness of the time at which it arrived. Yet twenty-five years ago it was not by any means sure that the incandescent lamp would not itself be worsted by its great rival, the arc lamp; in fact, a great many men of leadership and of force both as inventors and as capitalists, persisted in working at the development of the arc to the neglect of the incandescent. Times have changed and now virtually every central station in the country, besides almost every isolated plant, is on an incandescent lighting basis, while the triumph of the incandescent lamp is most emphatically demonstrated in the fact that in the central station companies of the country the percentage of their income derived from incandescent lighting is 52.4, while arc lighting is only 28.1 per cent. Moreover, all other electric service consisting chiefly of electric motors is 17.7 per cent., and as the success of the motor has been associated also with the incandescent lamp it would appear that to-day the central stations of the country owe 70 per cent. of their income to the little lamp and less than 30 per cent. to the arc. Herein is justification and glory enough for Mr. Edison and for the other great workers in the field of incandescent lighting, and even they, as they look back across the brief space of twenty-five years, must wonder at the wonderful advances of that short quarter century.

DISTRIBUTED LEAKAGE ON TRANSMISSION LINES.

The article by Mr. F. F. Fowle on page 262 of this number relates particularly to the measurement of the insulation of long lines with distributed leakage, by the use of a voltmeter. This problem involves hyperbolic trigonometry for its simplest exposition and computation. The treatment in the article is partly hyperbolic.

There can be no doubt that the direct-reading voltmeter employed as an ammeter is far superior in practical use to a Wheatstone bridge for the measurement of line insulation in telegraphy or telephony. The time has not so long gone by when insulations of telegraph lines used to be measured at regular intervals with a battery and tangent-galvanometer. In these days of dynamos and motors it would be hard to find a place where a tangent-galvanometer would be capable of giving interpretable results; besides which the instrument is rel-

atively slow and insensitive. Nowadays, a common method of measuring insulation of telegraph lines is with a direct-reading voltmeter. By the use of a table, the readings of the voltmeter, when connected between line and a standard voltage, are immediately interpreted into apparent insulation resistances; and multiplying this tabular reading by the length of the line in miles, gives the insulation in megohm-miles. A tabular correction for each line can also be prepared for the effect of distributed leakage, which tends to make the apparent insulation of the line greater than the actual insulation, since the more distant parts of the line are virtually tested for leakage at a reduced pressure, owing to the loss of pressure in the nearer parts.

The formulæ suggested in the article are very unwieldly, and take long computation. Equally correct results may be obtained by shorter methods. The geometric mean of the apparent insulation and conductor resistance of the line gives the surge-resistance, and from this the true insulation of the line follows immediately. Or, when the conductor resistance of the line per mile may be regarded as known, this resistance divided into the product of the apparent conductor and insulation resistances of the line, gives as a quotient the insulation per mile corrected for distributed leakage. As pointed out, however, in the article, the correction for leakage is usually small when the line is short and in good electrical condition. It is only in the cases of relatively long lines of relatively large conductor resistance and poor insulation that the correction for distributed leakage upon the apparent insulation assumes large proportions.

On the Wave Length of Free Vibrations in Wireless Telegraph Antennae.

The conditions and rules affecting electric oscillations in a simple circuit, such as the circuit of a condenser connected to a reactance coil, are fairly well understood. Observations with spark discharges, with oscillographs, and with stationary waves, seem fairly to corroborate the theory. So also in the case of single long wires, or pairs of wires, the waves that run to and fro over their surfaces are fairly well within our mental grasp; but the more complex cases that present themselves when vertical antennæ are linked with local oscillation circuits, are not so thoroughly understood, and experimental evidence in such cases is valuable as a check upon theory. The article by Dr. J. E. Ives appearing on page 260 throws experimental light upon the oscillations of a vertical antenna when connected with a localized oscillation system at its base. It has been known for some time, both from theory and from observation, that although the linear capacity and the linear inductance vary from point to point along a vertical antenna, yet the two quantities always vary reciprocally, and in such a manner that the waves of free disturbance run up and down the antenna with the velocity of light in air. Or, possibly, the reverse mode of thought may be the more logical, and we may say that since unobstructed waves must have the velocity of light in air, the linear inductance and capacity of the antenna at every point are such as will permit of this state of affairs.

Consequently, if we take a 30-meter antenna, a wave will, in a single complete period, run up and down positively and then up and down negatively, making four trips to the complete oscillation, which will last one-tenth of a microsecond in all. It follows from this that four times the antenna height, or 120 meters in the case considered, will be the length of the free emitted wave as it runs off over the earth's surface, provided that there is practically a perfect ground connection at the base of the antenna. When, however, the antenna is loaded by the insertion of an inductance coil at the base, it is known that two things happen: First, there will be an oscillation set up in the complete system of antenna plus load; and, second, there will be oscillations set up in the antenna on its own account, and also in the load on its own account. In other words, the surge-resistance of the antenna being different, in general, from the surge-resistance of the inductance coil, there will be a partial discontinuity, or partial barrier, at their junction, whereby waves passing from one to the other are partially reflected back, instead of going on. The effect is similar to hanging a pendulum of, say, two feet in length, to the bob of a six-foot pendulum. Such a compound pendulum will not only be capable of performing swings as a single system of, say, seven feet in length, but will also vibrate as two independent although mechanically-connected systems, each for itself.

If, however, the surge-resistance of the localized oscillation system be made the same as that of the antenna, then there will be no intermediate discontinuity or reflecting barrier, and the loaded system will oscillate singly, emitting a single series of waves, or waves and harmonics, instead of three associated series of waves, or waves and harmonics. This adjustment of the surge-resistance of the localized system, into equality with the surge-resistance of the antenna, is called tuning the system to the antenna. When the generating system is so tuned there is naturally a marked increase in the power of the waves and frequency of the loaded or compound systems so unified. The illustrations in Dr. Ives' article clearly indicate the effect of loading the antenna on the length of its compound emitted waves. With ten and a half turns of his drum inductance coil, the wave length of the loaded system was double that of the unloaded antenna. With twenty-one turns of the drum the wave length was three times that of the unloaded antenna. When the local oscillation system was tuned to the antenna, the waves in the antenna had an amplitude many times greater than when the antenna and the local system were markedly discordant. It is evident that co-operation between the parts of a wireless generating system is as important as in human affairs; or, that the importance of pulling together, upon the success of a result, is as manifest in the inorganic as in the organic world.

Power Plants as Investments.

The question is often asked by business men as to whether the power transmission plants, now often installed on a very large scale, pay as business propositions. Every one is willing to admit that as engineering feats they are highly successful—but how about the result when the dollar and cent test is vigorously applied? The ultra-conservative are grimly reminiscent of the early days of electric lighting and the doleful tales of failure that are still current. It is a question of very wide scope, this of financial returns, so wide as to be indefinite as would be an inquiry regarding the paying properties of a hardware store, or a saw mill, or a tannery, or a drug store. There is nothing about the electrical business that separates it, as regards its financial features, from any other investment. Its product—power—is always in demand in proper markets, and its manufacturing plant can be erected and operated at an easily ascertainable cost. Building an elaborate plant for a small, uncertain and oversupplied market is simply a piece of financial foolishness like starting an artificial ice factory in Vladivostock or a central heating plant in Aden. The fortune that befell the immortal venture of Lord Timothy Dexter in shipping a cargo of warming pans to Havana cannot be counted upon with regularity in any business—electrical or other. On the other hand, the careful choice of location with reference to raw material and the sale of product, and sound management, will reap their reward as surely in the power business as anywhere else, and very many power transmission plants have given regular and generous returns upon the investment made.

But the strongest claim of electrical power transmission as a practical conservative field of investment lies in the increasing demand for its product on a wholesale scale. The country is rapidly being covered by a network of electric roads, many of them long, and using large amounts of power; the use of electric light is increasing with enormous rapidity; and now electrochemical processes are constantly arising to demand cheap power in very large quantities. Meanwhile, the tendency of fuel prices is steadily upwards, and while in any given year they may seem reasonable, one never knows when they may rise to almost prohibitive figures. With power-using processes steadily on the increase and the cost of fuel very unlikely even to stay down upon its present plane, the utilization of material sources of energy takes on a new importance. A wise manufacturer will to-day adopt electric power even if it shows no present saving over the cost of power from coal, since a great hydraulic plant is a permanent institution with which a long-time contract can be made, looking forward to the average scale of fuel prices for twenty years to come. By making such a contract the interests of both parties are advanced by insuring stability on the one hand, of costs; on the other, of income. Every year the supply of electrical power takes on more and more the character and solidity of a wholesale business. The great plant of the future will not bother itself much about the minute details of distribution, leaving that to be taken care of by local interests, but will devote its energies to cheapening production and to distributing the product over long distances, making long time contracts with its customers, and deriving its revenue from large and reliable sources. So organized, it must rank as an investment of the "gilt-edged" order.

THE REPULSION MOTOR FOR TRACTION.

The papers read at the Institute meeting by Dr. Steinmetz and Mr. Slichter may be taken to represent the line of action of the General Electric Company in the development of alternating-current motors for traction purposes. It has for some time been an open secret that a General Electric single-phase alternating-current motor was under way, and, in fact, perhaps as far along toward commercial application as the alternating motors which have been already announced. The Thomson repulsion motor is one of the most individual and striking of the alternating type and would long ago have been heard from in general power work had it not been possessed of the very characteristics of a series motor which now make it especially useful. Its principle is very simple. Any electric motor must have a magnetic field, wires movable relatively to the field and carrying current, and some means for organizing the resulting torque into continuous rotary motion. In direct-current motors the commutators serve the end last named by systematically reversing the current in the armature coils at the proper times. In the ordinary polyphase induction motor, the workng current being induced in the armature by the field windings is clear out of phase with the magnetization, and is swung into place by the device of providing two or more field windings fed by currents of different phase which serve in cyclic order as transformer and as field coils. In the single-phase induction motor of the ordinary kind there is a compensating phase shift from armature reactance, but a rather unstable one. The Thomson repulsion motor has a simple alternating field, which induces the armature currents, but the latter are organized by short-circuited brushes so as to give a definite polar displacement—as definite as in a continuous-current motor.

As a result of this construction the motor performs well over a wide range of speed, and the machine has, in fact, many of the properties of a series-wound, direct-current motor. Mr. Slichter's curve No. 1 gives a capital idea of the general properties of the repulsion motor as organized for traction purposes. The power factor is much like that of a well-designed polyphase induction motor, holding above 85 per cent. over a wide range of speed. The efficiency curve is likewise steady over a wide range of speed, but is nowhere very high, hardly as high as in common induction motors of similar output. This deficiency may be charged up to the rather large mass of iron which suffers hysteretic loss in a single-phase motor, and is shared by all the types of alternating traction motors on which data have thus far been made public. This deficiency is less marked in the motor compared with a direct-current railway motor in curve 2, but is still conspicuous. Nevertheless, the alternating motor makes a very creditable showing. It is a pity that the power factor curve was not given for this motor, but from the data given it appears to have been respectable. During acceleration the alternating motor has a certain advantage in net efficiency due to the fact that reduced voltage can be obtained with very slight loss of energy, while the direct-current motor suffers from its rheostat. Just how much this advantage will count for in practice it is difficult to say. The repulsion motor shares with the direct-current motor the somewhat problematical advantage of being able to return energy to the line when reversed. It is an interesting property to possess, but has never yet been put to much use in electric railroading. Mr. Slichter's final curves are the computed values for a 175-hp motor, and show properties similar to the others. We regret that all his curves were not obtained from a single machine, as it is difficult to judge results from a torque curve of one motor, an acceleration curve of another, and some other curve of a third; but the general results leave the impression of a pretty useful type of machine with some especial advantages.

In discussing the theory of the motor, Dr. Steinmetz displays his usual deft touch and follows his usual method of treatment. He gives, however, in addition, a very interesting account of the early work of the late Rudolph Eickemeyer on series-wound commutating motors for alternating current. It constituted a wonderfully clever bit of electrical engineering, but was hopelessly handicapped by the prevalent high frequency, which fact should be borne in mind in inspecting Fig. 4 of Dr. Steinmetz's paper. Under present conditions the series alternating motor, as developed, for example, by Dr. Finzi, shows as high a power factor as could reasonably be asked. We refer here to the Finzi motor merely because it is stated to be an unmitigated series machine without any unusual features in the winding. The vital question with respect to all these new alternating motors is the sparking. It is uniformly reported to be small, or negligible, or absent under working conditions. Unhappily, there is no exact method of defining the amount of sparking, and individual judgment in spite of the best intentions is liable to bias. Even the renowned Liebig, who firmly disbelieved in bacterial action, when shown a vigorous colony under the microscope, is said to have closed the eye over the tube, asseverating that he saw no bacteria at all. There seems to be little doubt that the new alternating railway motors have good practical qualities in a general way; that they give ample torque; have very respectable power factors, and efficiency enough to make the distribution via rotary converters look like wilful waste. But there is as yet no good way of settling the sparking question. A few months of actual service in charge of hardened old railway men will bring out the facts with a thoroughness not to be reached in shop tests. And we hope that ere long enough of the new motors will be in service to secure just this sort of trial. If from it they emerge triumphant, it is safe to say that for the future the direct-current railway motor will have to assume the defensive and show cause why it should not be replaced.

The Annual Dinner of the American Institute of Electrical Engineers.

The annual dinner of the American Institute of Electrical Engineers will be held in the main ball room of the Waldorf-Astoria, New York City, Thursday, February 11, 1904, at 7 P.M., precisely. The guest of honor will be Mr. Thomas Alva Edison, and it is expected that an opportunity will be given to meet Mr. Edison at an informal reception, at half-past 6. This dinner will commemorate the twenty-fifth anniversary of the introduction of the incandescent lamp, and will also celebrate Mr. Edison's birthday. Upon this occasion will also be presented the deed of gift of the Edison Medal Association, which has raised a fund of several thousand dollars.

The following guests have accepted invitations: Mr. Ambrose Swasey, president American Society of Mechanical Engineers; Dr. A. R. Ledoux, president American Institute of Mining Engineers; Col. Robert Clowry, president Western Union Telegraph Company; Mr. George G. Ward, vice-president and manager Commercial Cable Company; Mr. W. H. Baker, vice-president Postal Telegraph Cable Company; Mr. John Fritz, founder Bethlehem Steel & Iron Works; Mr. W. H. Fletcher, president Engineers' Club; Mr. A. B. Chandler, president Postal Telegraph-Cable Company.

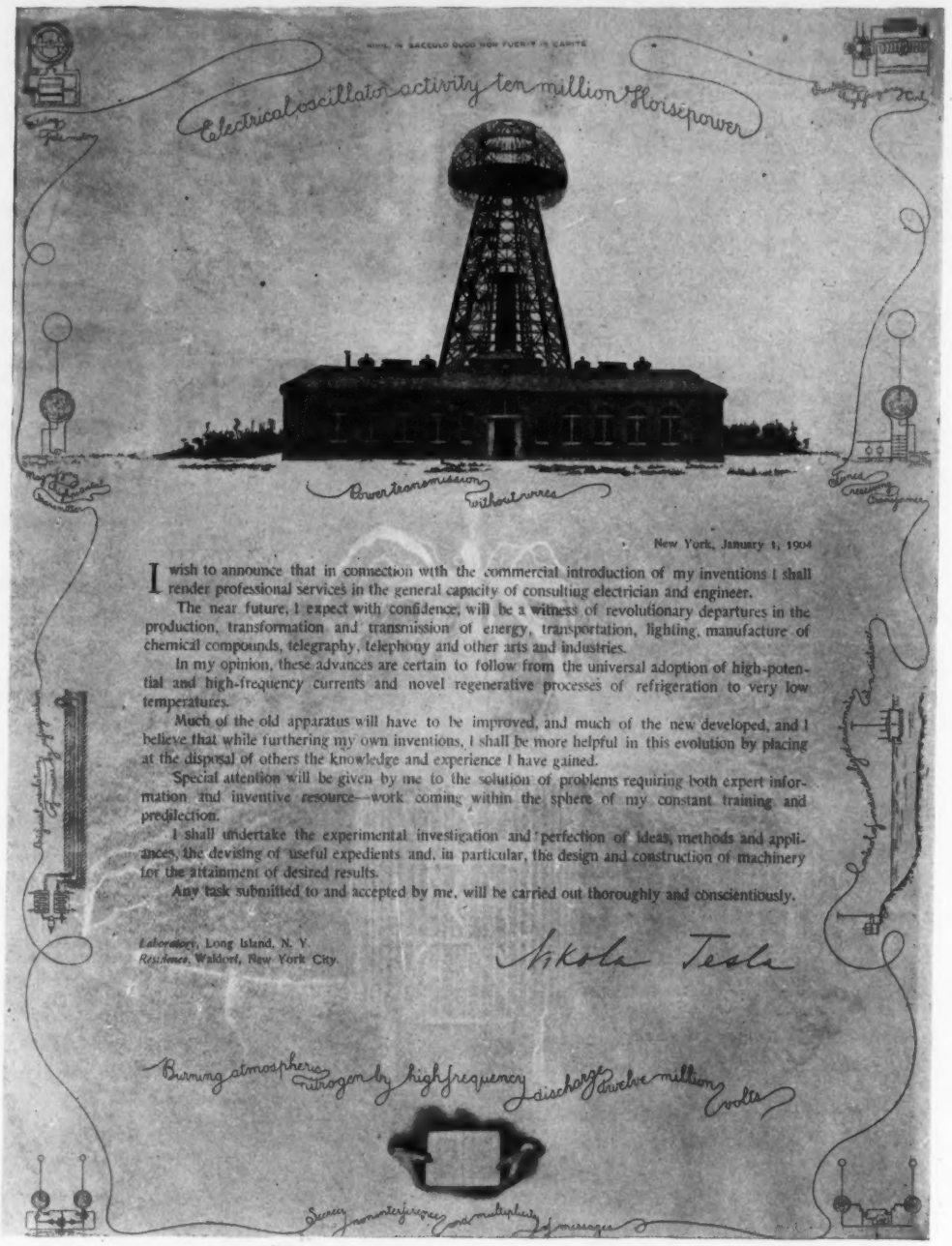
Autographed souvenir menus have been prepared containing a colored photogravure of Mr. Edison and two original poems prepared by Mr. R. R. Bowker. The exercises will be as follows: Salutatory address by President B. J. Arnold; presentation of the medal fund and deed of gift by Mr. Samuel Insull, chairman of the Edison Medal Association; acceptance of same on behalf of the Institute by Dr. A. E. Kennelly, of Harvard University, past president; address on behalf of the colleges and universities by Prof. Cyrus F. Brackett, of Princeton University; address on behalf of the Association of Edison Illuminating Companies by President J. B. McCall; address on behalf of the National Electric Light Association by President Charles L. Edgar.

Mr. Edison has flatly declined to speak, but in response to the toast in his honor has agreed to send from the table a telegraphic acknowledgment. It is a great many years since he used the key. He will use one of the original quad sets built by him for, and loaned by the Western Union Telegraph Company. The message will be received in the banquet hall on a Postal quad of latest date by President A. B. Chandler, of the Postal Telegraph Cable Company, and will then be read to the audience. These arrangements are in the hands of Mr. C. P. Bruch, assistant general manager of the Postal system, and Mr. J. C. Barclay, chief engineer of the Western Union system. A number of special cable messages and telegrams will also be received at the same time.

The seating arrangements provide for the accommodation of eight persons at each table. Orders for seats should be sent in at once and should be accompanied by cash or check, payable to Mr. Ralph W. Pope, secretary. Price of tickets, without wine: Gentlemen, $7; ladies, $5; admission to galleries, $1. In order to secure accommodation, responses should reach Mr. Pope not later than February 9, 1904, 95 Liberty Street, New York. Mr. Arthur Williams, chairman of the committee on decorations, has made elaborate preparations for ornamenting and illuminating the ball room, and the effect will be very pretty and appropriate.

A Striking Tesla Manifesto.

We reproduce herewith in slightly reduced fac-simile the first page of a four-page circular which has been issued this week by Mr. Nikola Tesla in a large square envelope bearing a large red wax seal with the initials, "N. T." At the back of the page which we reproduce is given a list of 93 patents issued in this country to Mr. Tesla. The fourth page is blank. The third page has a little vignette of Niagara Falls and is devoted to quotations from various utterances of Mr. Tesla. The first of these is from his lecture delivered in 1893 before the Franklin Institute and the National Electric Light Association, as to transmission of intelligible signals and power to any distance without the use of wires. The second quotation is from his article on the problem of increasing human energy, which appeared in the *Century Magazine* in June, 1900, dealing with virtually the same subject. The third item quotes from his patents, Nos. 645,576 and 649,621, dealing with the transmission of electrical energy in any quantity to any distance, with transmitting and receiving apparatus movable as in ships or balloons. The circular is an extremely interesting one. It is most sumptuously got up on vellum paper and altogether constitutes a manifesto worthy of the original genius issuing it. It is to be gathered from the circular that Mr. Tesla proposes to enter the field of consulting engineership, in which he already has enjoyed an extensive connection here and abroad.


Electrical oscillator activity ten million Horsepower
Power transmission Without wires
New York, January 1, 1904
I wish to announce that in connection with the commercial introduction of my inventions I shall render professional services in the general capacity of consulting electrician and engineer.
The near future, I expect with confidence, will be a witness of revolutionary departures in the production, transformation and transmission of energy, transportation, lighting, manufacture of chemical compounds, telegraphy, telephony and other arts and industries.
In my opinion, these advances are certain to follow from the universal adoption of high-potential and high-frequency currents and novel regenerative processes of refrigeration to very low temperatures.
Much of the old apparatus will have to be improved, and much of the new developed, and I believe that while furthering my own inventions, I shall be more helpful in this evolution by placing at the disposal of others the knowledge and experience I have gained.
Special attention will be given by me to the solution of problems requiring both expert information and inventive resource—work coming within the sphere of my constant training and predilection.
I shall undertake the experimental investigation and perfection of ideas, methods and appliances, the devising of useful expedients and, in particular, the design and construction of machinery for the attainment of desired results.
Any task submitted to and accepted by me, will be carried out thoroughly and conscientiously.
Laboratory, Long Island, N. Y.
Residence, Waldorf, New York City.
Nikola Tesla
Burning atmospheric Nitrogen by high frequency discharge Twelve million Volts

PAGE FROM CIRCULAR SHOWING TESLA TOWER, WARDENCLIFFE, LONG ISLAND.

Three-Wire Direct-Current Railway System.

THE country in the neighborhood of Grenoble, suituated as it is in the Alpine region to the southeast of France, is justly renowned for its picturesque scenery, and this part of the Dauphiné is visited by numerous tourists every year. On the other hand, a certain number of villages, especially those lying in the picturesque valley of Gresivaudan, were lacking in a good means of communication. Owing to these reasons it was considered desirable to construct an electric railway system which should start from Grenoble and take in a number of the surounding localities. Hydraulic power, which is already used to such a large extent for operating electric plants in the Grenoble region, was called upon here to give the necessary current for the plant.

The line which has been recently constructed starts from Grenoble and runs to the town of Chapareillan, covering a total distance of 26 miles. It gives tourists an opportunity to admire the natural beauties of the country and its advent has been warmly welcomed by the inhabitants of the different localities, as it has given a great stimulus to the commerce and industry of the region.

The Grenoble system presents a novel feature in the use of the direct-current, three-wire system for supplying the motors of the cars. The trolley line is double and constitutes the two outside wires of the system. The middle wire is connected to ground. The motors work

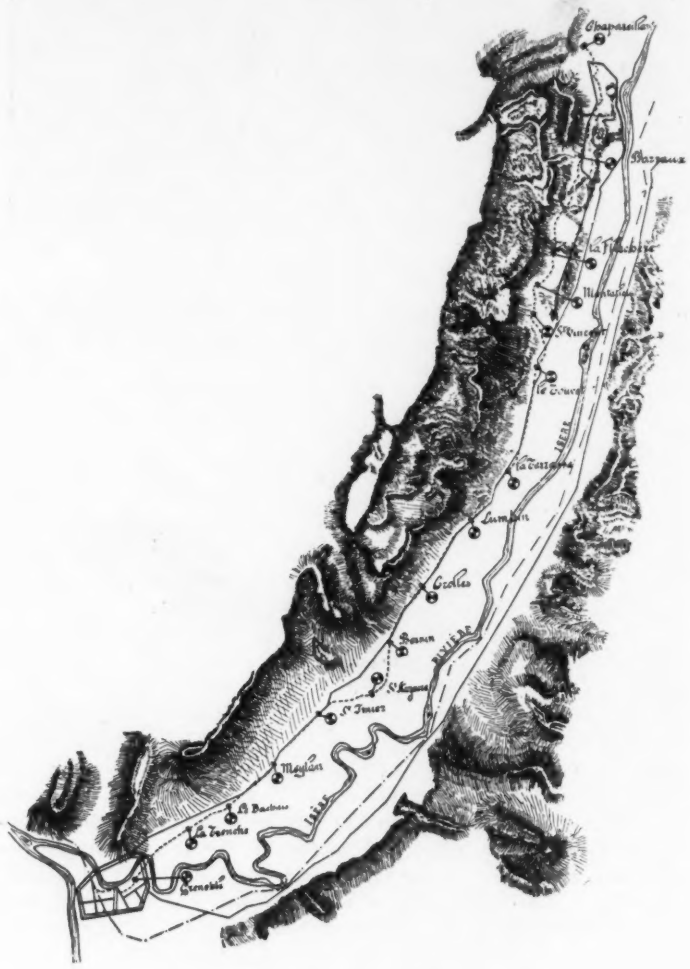


FIG. I.—MAP OF LINE.

two in series upon 1,200 volts between the trolley wires. The middle connection between the motors is grounded.

Up to the present the maximum voltage which has been employed for direct current traction systems in Europe varies from 550 to 650 volts. The limit of tension, which is relatively small, kept the section of copper which is needed for the circuits at a high value. While the three-wire system now effects a considerable saving in copper for lighting and power circuits, it has not been applied to any extent upon electric traction systems, and therefore a description of the Grenoble-Chapareillan road may prove not without interest.

The tension of the overhead line at the terminals is 1,200 volts, the third or neutral wire being connected to the ground by means of a copper cable of 125 square millimeters section which is connected to the rails of the track, this forming the return circuit.

After leaving Grenoble the traction line crosses the Isère River and follows along its right hand. Besides a number of small villages, it supplies the stations of Meylan, Montbonnot-St. Martin and St. Ismier. It crosses the torrent of Manval over a metallic viaduct of 50 ft. length, and passes through Bermin, Crolles and Lounet. After crossing the torrent of Bresson by a stone-arched bridge 40 ft. long, it passes through St. Vincent de Mercuze and Barraux, and finally arrives at the terminus at Chapareillan after crossing the stream of

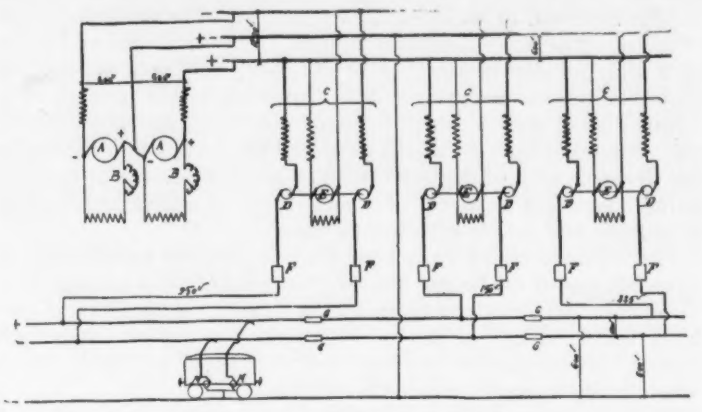


FIG. 2.—DIAGRAM OF CIRCUITS.

the Cernon over a steel bridge of 32 ft. As will be observed, the construction of the line has not required a great amount of engineering work, but steep grades have been frequently met with. The altitude of Grenoble is about 212 meters above the sea-level. The highest point of the line is at La Flachère, which is situated at 423 meters above sea-level. The difference of level between these two points is thus more than 200 meters. It is in the neighborhood of La Flachère that the heaviest grades are encountered.

The total length of the traction line is 26 miles. The overhead line consists of two hard-drawn copper wires 9 millimeters in diameter stretched at a distance of 28 inches apart. The line is supported by bracket poles or by suspension wires which are stretched across the track from poles or rosettes. At the crossing points, four overhead wires have been established, as also at the larger stations along the line, in order to allow the cars to be easily switched. The portion of the track which has been laid within the city of Grenoble is constructed of grooved rails on the Broca system weighing 80 pounds per yard. Outside the city the track is laid with rails of the railroad type which weigh 50 pounds per yard. The line is of one meter gauge throughout the entire length. Special care has been given to secure the proper bonding of the rails.

The motor cars and trailers for the Grenoble line have been constructed by the Compagnie Française du Material de Chemins de Fer, at the large establishment at Ivry, near Paris. The cars have been fitted out by Schneider & Company, of Creusot. The motor cars are of the usual tramway pattern with central passage and side seats, with sufficient motor capacity to draw two trailers of the same size or a freight car. These cars will contain 36 persons and their weight when empty is 9.2 tons. Each of the motor cars is equipped with two four-pole motors of the Thury pattern which have a capacity of 35-hp each. The motors are coupled in series and work at a tension of 1,200 volts. The starting switches and resistances are placed on the roof of the car and are operated from the motorman's platform by a hand-wheel and transmission system. The two ends of the car are symmetrical so as to avoid turning the car about at the terminal stations. When the car comes to the end of the line, the motorman detaches his hand wheel and carries it to the other platform. By putting it in place he makes an automatic connection which changes the direction of the current in the motors. The latter work on the single reduction system

The trains are made up usually of a motor car and two trailers, and are equipped with hand and electric brakes, which are applied on all the cars. The electric brakes can either receive their current from the overhead line, or the motors themselves are used as brakes, in which case the latter are operated as dynamos on short-circuit. The passenger cars are electrically lighted and heated. In this case the current is taken from only one of the overhead wires. The car carries two trolleys which use the ordinary type of pole; the trolley

itself consists of a sliding cross-bar which is pressed against the overhead wires by a spring giving a pressure of 22 pounds. The present plant is laid out so as to secure the continuous operation of 9 trains of 30 tons each, comprising 8 trains for passengers and one freight train. Of the latter several different types of cars are now in use as well as a combination freight and passenger train.

The generating station which supplies the entire line is situated at Lancey, a small village about 10 miles from Grenoble and along the line of the road, but distant from it by three kilometers, lying on the other side of the Isère River. The water is taken from a hydraulic establishment which has been already installed by M. Berges. It affords a head of water of 1,470 ft. with a large available supply of power. The water arrives at the new hydraulic station of Lancey by a high-pressure penstock of riveted sheet iron, at a pressure of about 600 pounds per sq. in. It is distributed to the turbines by a large collector conduit which is placed outside of the station building. From the main conduit a separate branch runs into the building to supply each of the turbines. The latter, which are of the centrifugal type, are provided with gate-valves of special construction in order to take up the high water pressure.

The turbines, which have been built by Brenier and Neyret, of Grenoble, one of the largest French constructors, are at present three in number, of which one is used as a reserve. Each of these turbines has a capacity of 340-hp and operates at 325 revolutions per minute. These turbines are provided with speed regulators which keep the speed nearly constant at varying loads.

As the turbines use a considerable water supply, it became very difficult to measure the water which passed through them by a direct method. M. Berges adopts an indirect method by which a fractional part of the water is measured. The water coming from the turbines passes into the bottom of a large funnel-shaped recipient and mounts to the top. The upper portion of the vessel is cylindrical and is pierced with 80 rectangular openings or windows which are disposed around the periphery. These openings have been carefully calibrated to the same size and the lower edges are all on the same line. The water which arrives in the reservoir will flow out of the openings, and the height of the water in the opening gives an indication of the volume of flow. The system thus gives 80 streams of water, all alike, seeing that the size of the openings is equal.

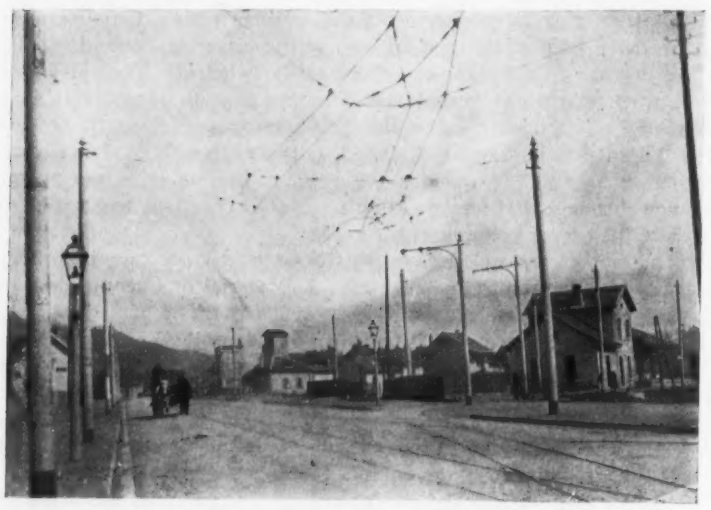


FIG. 3.—OVERHEAD CONSTRUCTION.

One of these streams is then used to measure the volume of the total flow. The stream which is chosen for the purpose is sent through a water-meter of suitable construction and it only remains to multiply the reading by 80 in order to obtain the final result.

The station is equipped with three railway generators which deliver continuous current for the line. These generators, which have been constructed by Schneider & Company at the large Creusot works (France) are direct-coupled to the turbines which have been previously mentioned. They are of the Thury type with the hexagonal form and consequent pole disposition which is characteristic of this system. These machines have a capacity of 420 amperes and operate at 600 volts. The field, which has 6 poles, is compound wound. The fine wire winding of the field circuit has in series with it a rheostat for the field regulation. An automatic Thury electric regulator is used to operate this rheostat, and keeps the difference of potential at the bus-bars constant.

The two generators which are employed for the tramway lines are coupled in series, with a neutral wire coming from the middle connection, so as to produce a difference of potential of 1,200 volts between the end bars of the switchboard, of 600 volts between each of the outside bars and the middle. The distribution switchboard of the machines carries the apparatus which are generally employed in traction plants, together with some special devices which are needed for working the two machines in series on the three-wire system. The middle or neutral bar of the switchboard is connected directly with the tramway rails, which serve as a return conductor. The connection is made by a cable having a section of 125 square millimeters copper.

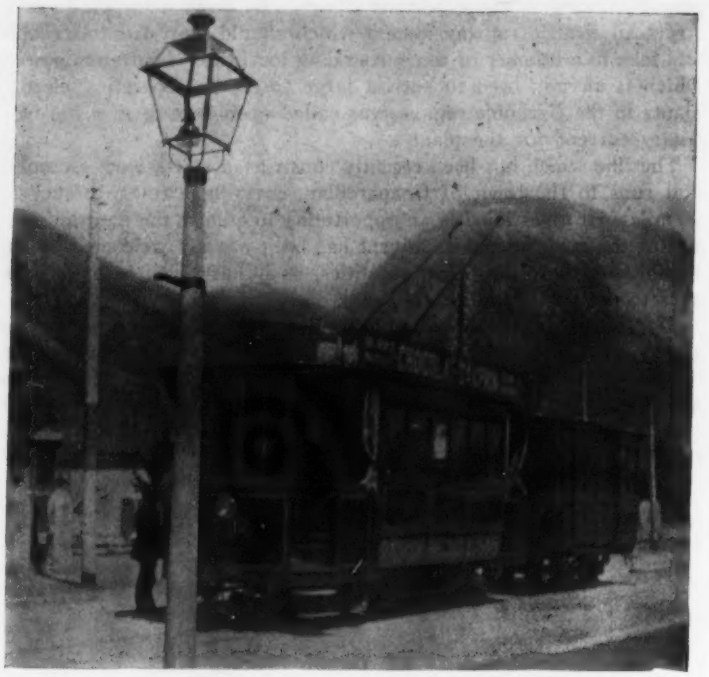


FIG. 4.—MOTOR CAR AND TRAILER.

From the bars of the switchboard start three groups of two feeders each, for supplying the traction line. In consequence, the feeding points are three in number and the cables are connected in at the points where the consumption of current and therefore the drop in the line is the highest. These points occur at Grenoble and Chapareillan, the ends of the traction line, and at Les Drogeaux, near the middle. In order to compensate automatically for this drop in the line, each of the feeders is made to pass through a booster group which is composed of a motor and two generators which give the extra voltage.

The motors of the booster groups are connected across the end bars of the switchboard, or upon 1,200 volts. Their fields are compound-wound and the motors are thus able to operate at a nearly constant speed under varying conditions of load. The motors vary in size and horse-power according to the number of volts which the generators they drive are required to furnish for the boosting action. The Grenoble feeder requires 360 volts, and the Chapareillan feeder 225 volts. The third feeder connecting in at Les Drogeaux needs but 150 volts additional. The booster set for the Grenoble feeder is composed of a motor which drives two generators having a total capacity of 80-hp. The second group uses a 56-hp set consisting of a motor which drives two four-pole generators and gives 225 volts. The group for the Les Drogeaux feeder is similar, but gives only 40-hp. In all these groups the generators which serve as boosters are direct-connected to the motors by Rafford elastic couplings and work at constant speed. The generators are series wound.

Before connecting with the traction line the feeders pass through a second switchboard where connection is made with the booster circuits. The switchboard carries the measuring and regulating apparatus which are usual in such case; among others, a set of automatic circuit-breakers placed on the feeders protects the boosters against overloads or short circuits. An automatic mechanical device is used with the boosters. Each machine carries at the end of the shaft a governor which comes into action should the boosters tend to rotate in the opposite direction. It throws the armatures of the

boosters in short-circuit in the case where the motor is disabled, so as to prevent the generators from acting as motors under the current which they receive, in which case they would have a tendency to race, seeing that they would then work under no load. Improved lightning arresters of the Thury pattern give an efficient protection of the circuits. These lightning arresters are formed of a long articulated arm, which carries a set of teeth on the extremity and breaks the circuit by drawing out a long arc.

The general arrangement of circuits for the Grenoble system is shown in the diagram, Fig. 2, where *A* is the compound-wound generator; *B*, automatic rheostat for generator; *C*, booster group; *D*, series booster; *E*, compound-wound booster of motor group; *F*, automatic circuit breaker; *G*, section insulator; *M*, car motor.

The main three-wire circuit which will be noted in the upper part of the diagram, starts from the Lancey hydraulic station, crosses the railroad line on a special bridge and then traverses the isère River which is about 400 ft. wide at this point. The three-wire circuit is formed of 6 conductors of bare copper, having a section varying from 125 to 65 square millimeters and a return cable of 125

FIG. 5.—END VIEW OF A CAR.

square millimeters section. A telephone line which unites all the tramway stations and posts of the sytem follows the same traject. All the conductors are supported by double porcelain insulators which are fixed upon metallic poles of the André system.

The above description will serve to bring out the main features of this somewhat novel system of traction lines. The operation of the road from the start has proved eminently satisfactory, and does credit to the system of direct-current motors and generators which has been designed by M. Réné Thury and which are now in successful operation in a large number of European plants. The use of boosters in connection with a plant of this kind will also be remarked as somewhat of a novelty.

N. E. L. A. Convention Date.

The date of the twenty-seventh annual convention of the National Electric Light Association has been fixed by the executive committee. The meeting will be held in Boston, May 24, 25 and 26, a very agreeable period of the year in that vicinity. The name of the hotel selected as headquarters has not yet been announced.

Legal Conditions of Co-operative Telephony.

A very interesting decision as to the rights of a member of a "co-operative" telephone company has recently been given by the Supreme Court of the State of Indiana in the appeal of Arthur B. Irvin against the Rushville, Ind., Co-operative Telephone Company. The lower decision in favor of the company was sustained. The company has been for more than eight years past engaged in carrying on a general telephone business in the city of Rushville, Ind., and had, at the time of its organization, adopted the plan of allowing patrons who desired telephone service to become stockholders in the company, to purchase and own their own telephones, and to purchase and own their own wires leading from the location of their said telephones over the pole lines of the defendant to its exchange, and to pay a rental at the end of each month of a sum sufficient to pay the operating expenses of said company. Under this arrangement the plaintiff purchased and paid for one share of stock in said company, purchased a first-class telephone, and also paid for a line of wire leading from his residence to the local switchboard. A dispute arose over the monthly payment and at last Mr. Irvin was cut off. The points are enumerated clearly below summarizing the decision, which is of more than usual interest:

"Where, in an action against a telephone company for refusing to furnish plaintiff with switchboard connections, the complaint did not allege that there had been any discrimination against plaintiff's 'business,' it did not state a cause of action within Burns' Rev. St. 1901, §5529, providing that no telephone company shall discriminate against any individual or company engaged in any lawful business.

"A rule of a co-operative telephone company that all moneys due from its patrons for toll-line connections are payable on or before the 5th day of the month succeeding the maturity of the indebtedness, and, if not paid, the service of the delinquent patron shall be disconnected until the indebtedness is paid, is a reasonable regulation, which the company is entitled to enforce.

"Where a telephone company had promulgated a rule that claims for service must be paid on a particular day on pain of having the patron's service refused, and the patron was charged with notice of the rule, and with the fact that he had violated it, the telephone company was justified in refusing service without informing him at the time of its refusal as to its reason therefor.

"Where a telephone company had established and promulgated a rule requiring payment of previous tolls on a particular day on pain of having the service discontinued, the mere fact that the company had not enforced such rule against third persons before cutting off plaintiff's service for non-compliance therewith did not of itself deprive the company of its right to enforce the rule against plaintiff.

"Where a public telephone company had promulgated a rule requiring payment of past tolls by subscribers on a particular day on pain of discontinuance of service, it was entitled to enforce payment of such dues and tolls by denying service, regardless of the fact that the subscriber claimed that the company was indebted to him to an amount exceeding the tolls due.

"Where, in an action to recover a statutory penalty against a telephone company for cutting off plaintiff's service for its failure to comply with a rule requiring payment of past tolls on a particular day, the complaint alleged that the rule had not been enforced as against 35 other patrons of the company who 'were in like situation with the plaintiff,' but did not allege that such other patrons were in default, or had refused to pay, it was insufficient to show a discrimination against plaintiff in the enforcement of the rule prohibited by Burns' Rev. St. §5529.

"Plaintiff owned stock in a co-operative telephone company, together with his telephone instrument and his line of wire to the exchange. Plaintiff was entitled to exchange connections on payment of certain tolls, and was subject to a rule providing that the company might discontinue connections for failure to pay past tolls on a specified date. Plaintiff, claiming that the company was indebted to him in excess of tolls claimed, refused to pay the tolls, and his service was discontinued. Held, that such discontinuance did not deprive plaintiff of his property without due process of law."

A New Wireless Telegraph System.

A Washington dispatch states that the Department of Agriculture has perfected a system of wireless telegraph which differs both from the Marconi and De Forest systems. The system, it is stated, is now in successful operation between San Francisco and the Farallones Islands, a distance of about 27 miles.

On the Wave Length of Free Vibrations in Antennae and Closed Oscillating Circuits.

By Dr. James E. Ives.

CERTAIN experiments on the wave lengths of antennæ and of closed circuits, which I have recently made on behalf of the De Forest Wireless Telegraph Company, appear to me to be of sufficient general interest to warrant their publication. They deal with the change in wave length produced by inserting turns of a wire helix in the antenna, or in a closed circuit, and also with the reaction between a closed circuit and the antenna. All the experiments described were made at the De Forest station at the Hotel Castleton, Staten Island, N. Y.

The measurements of wave length were made with an instrument designed conjointly by Dr. Lee De Forest and the author. The details of its construction, the method of calibrating it and the manner of its use will be described in another article. The experiments may best be discussed by referring to the figures and diagrams.

Fig. 1 shows the effect of inserting turns of a wire helix in the antenna. A diagram of the connections is shown in the right-hand lower corner of the figure. *e* is the earth wire, going to the ground plate; *a*, the aerial wire passing through the roof of the station, and *h* is the helix. *a* consisted of two No. 14 wires about a foot apart, and 62 ft. long; *e* of a single wire about 27 ft. long. The total length of the antenna, measured to the earth plate was, therefore, about 89 ft. The helix had a diameter of one foot, and consisted of 21 turns of No. 14 wire, an inch apart.

The curve shown in the figure is very nearly a straight line, as

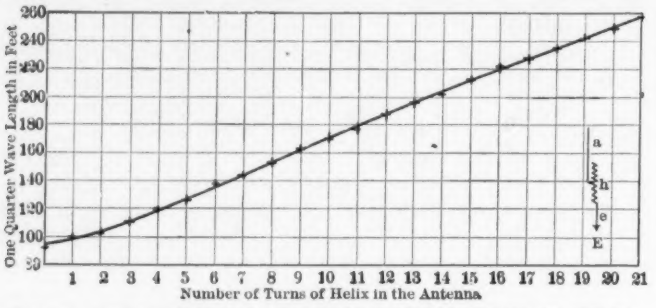


FIG. 1.—CURVE SHOWING EFFECT OF PUTTING TURNS OF HELIX IN ANTENNA.

might have been expected, since the wave length of the antenna varies as the square root of its inductance, and its inductance varies roughly as the square of the number of turns inserted. This may be stated mathematically as follows:

Let v represent the velocity of light or of electric waves in air.
n, the frequency of the electrical oscillations in the antenna.
λ, the wave length of the oscillation.
T, the period of the oscillation.
L, the inductance of the antenna.
C, its capacity.

Then since

$$v = n\lambda \qquad (1)$$

$$\lambda = \frac{v}{n} \qquad (2)$$

and since

$$n = \frac{1}{T} \qquad (3)$$

and

$$T = 2\pi \sqrt{LC}, \qquad (4)$$

$$\lambda = 2\pi v \sqrt{LC}. \qquad (5)$$

But

$$L = k^2 n^2, \text{ approximately,} \qquad (6)$$

where k is a constant, depending upon the shape and size of the helix. Therefore,

$$\lambda = 2\pi v k n \sqrt{C} \qquad (7)$$

But C, the capacity of the antenna, may be considered a constant for an antenna of a given height, since the potential loop being at its free end and the node at its base, the charge that it holds will not be much affected by putting in turns of a helix near its base. Therefore,

$$\lambda = n \times \text{constant} \qquad (8)$$

Fig. 2 deals with a closed oscillating circuit made up of four Leyden jars in series, and a certain number of turns of the helix

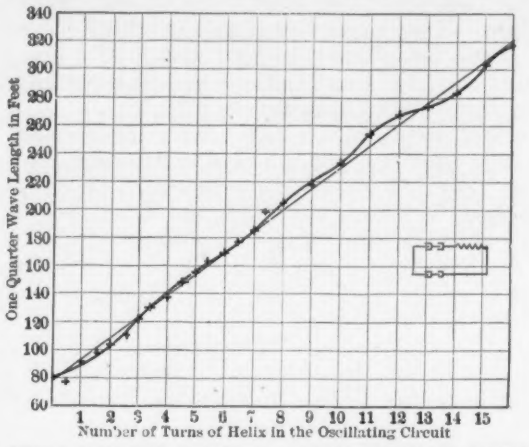


FIG. 2.—CURVE SHOWING EFFECT OF ADDING TURNS OF HELIX TO A CLOSED CIRCUIT.

already described. It shows how the wave length of the circuit is changed by adding turns of the helix. The quarter wave length is plotted as a function of the number of turns inserted. The curve varies irregularly on both sides of a straight line. For the reasons

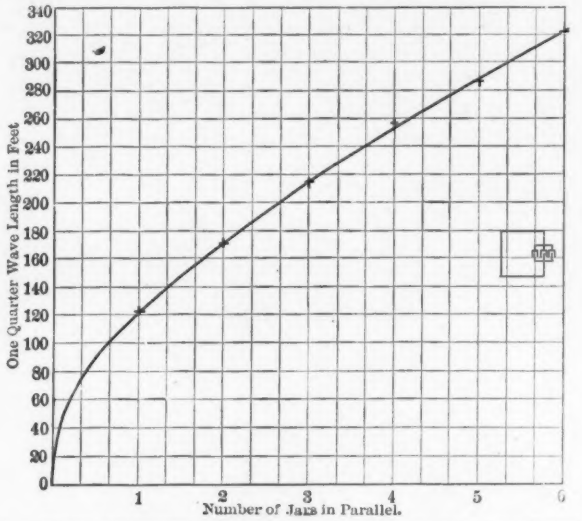


FIG. 3.—CURVE SHOWING EFFECT OF INCREASING THE CAPACITY OF A CLOSED CIRCUIT.

already given we should expect it to approximate to a straight line, since the wave length should be approximately a linear function of the number of turns inserted.

Fig. 3 also deals with a closed circuit and shows the effect upon its wave length of changing the number of Leyden jars inserted in

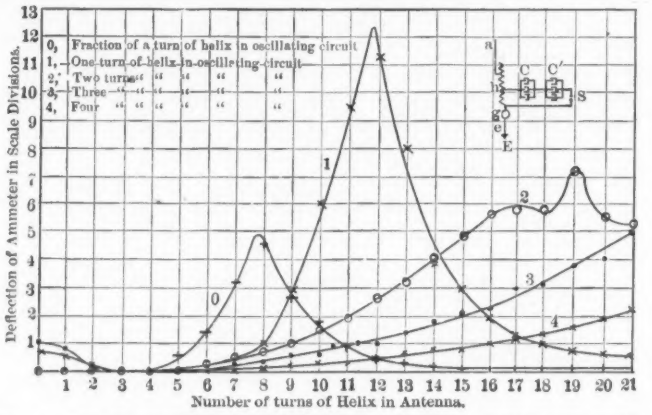

0, Fraction of a turn of helix in oscillating circuit
1, One turn of helix in oscillating circuit
2, Two turns " " " "
3, Three " " " "
4, Four " " " "
Deflection of Ammeter in Scale Divisions.
Number of turns of Helix in Antenna.
a
C
C'
S
E

FIG. 4.—CURVE SHOWING RESONANCE OF ANTENNA WITH THE OSCILLATING CIRCUIT.

its inductance is kept constant. The curve obtained is parabolic in form, as might be expected from equation (7), where it is seen parallel. In this case the capacity of the circuit is changed, while

that if the inductance remains constant the wave length of the circuit will vary as the square root of the capacity.

Fig. 4 is perhaps the most interesting curve of the series. As shown by the diagram of the circuits (in the right-hand upper corner of the figure), the antenna and the closed circuit are linked together, so that certain turns of the helix are common to both. The spark-gap is placed in the closed circuit, and the electrical disturbances set up in this circuit are, therefore, communicated to the antenna through the linked portion of the helix. The curve shows that the oscillating current in the antenna may be greatly increased by bringing the antenna into resonance with the closed circuit.

In the diagram, *a* is the antenna proper; *h* the helix already described; *e* the earth wire containing the hot-wire ammeter, *g*, on which the current readings were taken; *c* and *c'*, two sets of three Leyden jars, and *s* a spark-gap. The spark-gap was excited by an induction coil. The experiment was made by putting a certain number of turns of the helix in the closed circuit, and then varying the

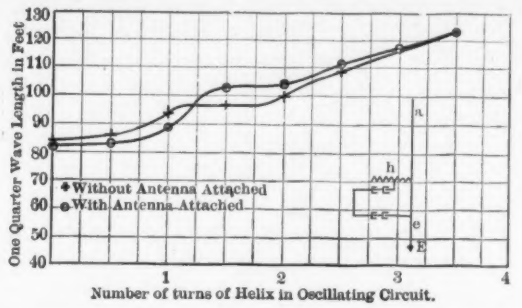


FIG. 5.—CURVE SHOWING EFFECT OF A LINKED ANTENNA ON WAVE LENGTH OF A CLOSED CIRCUIT.

number of turns in the antenna from 0 to 21. Five sets of readings were made giving the five curves shown in the figure. It is evident from the figure that for the cases of 3 and 4 turns in the closed circuit, more than 21 turns would have to be inserted in the antenna to

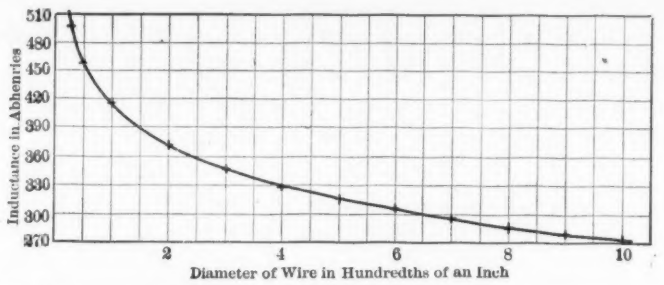


FIG. 6.—CURVE SHOWING RELATION BETWEEN THE INDUCTANCE OF A WIRE ONE FOOT LONG AND THE DIAMETER OF THE WIRE.

bring it into resonance with the closed circuit. The irregularity of the peak of curve 2 is perhaps due to the presence of an overtone.

Fig. 5 shows the results of an experiment made to determine how the wave length of a closed circuit is affected by a linked antenna.

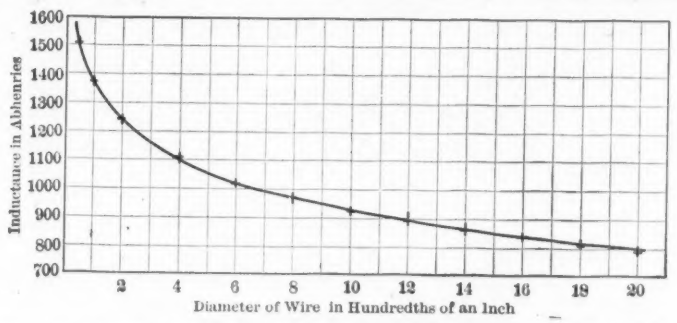


FIG. 7.—CURVE SHOWING RELATION BETWEEN THE INDUCTANCE OF A CIRCLE OF WIRE ONE FOOT IN DIAMETER AND THE DIAMETER OF THE WIRE.

The wave length of the closed circuit was first measured without the antenna attached, and then with it attached. The character of the closed circuit was varied by changing the number of turns of the helix. The connections are shown by the diagram in the lower right-hand corner of the figure. The solid and dotted curves respectively give the wave lengths for the two cases. It will be noticed that the two curves cross each other for a quarter wave length of 96 ft., which was the quarter wave length of the antenna as used in this experiment, i. e., without any turns of the helix. It will be noticed in the figure that for three and a half turns of the helix in the closed circuit, the two curves come together. For any number of turns greater than this it was found that the two curves still coincided. It therefore follows that when the wave length of the antenna is in the neighborhood of that of the closed circuit, the wave length of the closed circuit is decreased or increased by the linked antenna, according as the wave length of the oscillating circuit is less or greater than that of the antenna.

Figs. 6, 7 and 8 give theoretical and not experimental data. Fig.

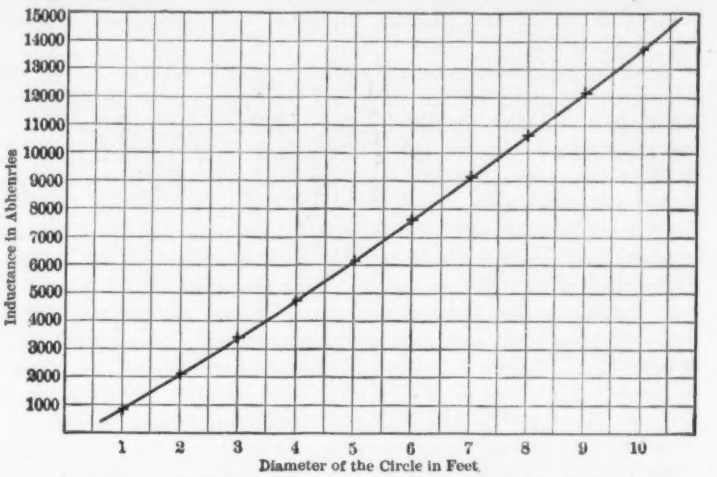


FIG. 8.—CURVE SHOWING THE RELATION BETWEEN THE INDUCTANCE OF A CIRCLE OF NO. 10 WIRE AND ITS DIAMETER.

6 is a calculated curve showing the relation between the inductance of a wire one foot long and the diameter of the wire. The diameter of the wire is given in one-hundredths of an inch, and the inductance in abhenries, or absolute units. The curve was calculated from the formula for rapid oscillations,

$$L = 2l\left[\log_e \frac{2l}{\varrho} - 1\right]$$

where l is the length of the wire, and ϱ its radius, both in centimeters. This curve can be used to calculate the inductance of a single-wire antenna of any length and diameter.

Fig. 7 is a calculated curve, showing the relation between the inductance of a circle of wire one foot in diameter, and the diameter of the wire. The diameter of the wire is given in one-hundredths of an inch, and the inductance in abhenries. The inductance was calculated from the formula for rapid oscillations,

$$L = 4\pi R\left[\log_e \frac{R}{\varrho} + .08\right]$$

where R is the radius of the circle, and ϱ the radius of the wire, both in centimeters.

Fig. 8 is a calculated curve showing the relation between the inductance of a circle of No. 10 wire and the diameter of the circle. (The diameter of No. 10 wire is .102 inch.) The diameter of the circle is given in feet, and the inductance in abhenries. This curve was calculated from the same formula as Fig. 7.

My thanks are due to my assistant, Mr. James B. Gottsberger, for his assistance in these experiments, and for plotting the curves.

Paris Subway Charms.

A cable dispatch to the newspaper press from Paris, dated January 23 says: "Vital statistics published lately concerning the Paris Metropolitan are not likely to encourage New Yorkers to seek jobs on Manhattan's new subway unless better conditions prevail. The figures show that since the Metropolitan was established, four years ago, no less than 50 per cent. of the employees have died, been killed or have left on account of bad health. The publication of statistics has started another spasm of reform, which may have permanent result in good." We think New York's subway will be able to do better than this.

The Measurement of Distributed Leakage on Transmission Lines.

By Frank F. Fowle.

THE line insulation of circuits employed in various kinds of transmission often determines one of the limits of commercial operation. Especially is this true as regards the effect of weather on very long lines of bare wire. On short lines the requirements of insulation are usually prescribed by considerations of electrical balance, stray foreign currents, lost energy, electrolysis and fire risks. On very long lines the requirements of insulation are usually prescribed by the permissible attenuation of energy. With bare wires the limiting weather conditions will determine the maximum attenuation.

There being no sources of potential in the leakage paths, the leakage will depend on the state and the material of the insulating covering on the wire, on the size, shape and frequency of the insulating supports and on the specific resistance, and the surface conditions of the supports. On long lines insulated wire is usually employed only at places exposed to injurious gases or contact with foreign wires or objects. On long aerial lines the leakage resistance is practically concentrated in the thin films of matter on the surfaces of the insulators. Dry wood is a very fair insulator if it has not been treated by any preserving process. Under wet weather conditions the poles and cross arms become conducting, to a very considerable extent, in those portions penetrated by moisture. The practice of fastening iron wires to the poles with staples, from the top to the butt below ground, as a protection from lightning, considerably increases the leakage in wet weather, in the case of circuits having earth returns. The surfaces of the insulators, which are dry under all conditions, constitute the constant part of the insulation resistance and these surfaces should be of maximum length and minimum breadth. Direct escape into the atmosphere is probably very slight except where saturated vapors of a conducting nature are encountered.

The number of insulating supports per mile varies from twenty-five to fifty; it may be assumed without question that the leakage on long lines is uniformly distributed. The methods of measuring insulation resistance are based on the laws of distribution of current and potential, in the steady state, on a uniform line possessing resistance and leakage. Consider a line of length l, of uniform resistance r, and leakage conductance g per unit length. The leakage conductance is the reciprocal of the leakage resistance per unit length.

If r = resistance in ohms per mile,
g = leakage conductance in mhos per mile,
l = length of the line in miles,
E = the potential of the line at any point x,
I = the current at the point x, the fundamental equations are:

$$-\frac{\delta E}{\delta x} = rI \tag{1}$$

$$-\frac{\delta I}{\delta x} = gE \tag{2}$$

whose solution may be derived as follows:

$$\frac{\delta^2 E}{\delta x^2} = -r\frac{\delta I}{\delta x} = rgE \tag{3}$$

$$\frac{\delta^2 I}{\delta x^2} = -g\frac{\delta E}{\delta x} = rgI \tag{4}$$

$$\therefore \quad E = A\,\varepsilon^{\beta x} + B\varepsilon^{-\beta x} \tag{5}$$

where A and B are the arbitrary constants of integration and ε is the base of the Naperian system of logarithms.

$$\frac{\delta^2 E}{\delta x^2} = \beta^2 E \tag{6}$$

from (5).

$$\therefore \quad \beta = \sqrt{rg} \tag{7}$$

From (1)

$$I = -\frac{1}{r}\frac{\delta E}{\delta x}$$

$$= -\frac{\beta}{r}\left(A\,\varepsilon^{\beta x} - B\,\varepsilon^{-\beta x}\right)$$

$$I = \frac{-A\,\varepsilon^{\beta x} + B\,\varepsilon^{-\beta x}}{K} \tag{8}$$

where

$$K = \sqrt{\frac{r}{g}} \tag{9}$$

The distribution of current and potential in the line is now determined in so far as the properties of the line determine it. The conditions at the two terminals determine the constants A and B, and completely solve the problem. At $x = 0$, the home or sending terminal, assume an e.m.f. acting on the line through a resistance. From (5) we have,

$$A + B = E_0 - I_1 r_1, \tag{10}$$

and from (8)

$$\frac{-A + B}{K} = I_1 \tag{11}$$

where I_1 is the current through the resistance r_1, due to the e.m.f. E_0.

At $x = l$, the distant or receiving terminal, assume the line to be closed through a resistance r_2.

From (5) and (8) we have,

$$A\,\varepsilon^{\beta l} + B\,\varepsilon^{-\beta l} = I_2\, r_2 \tag{12}$$

$$\frac{-A\,\varepsilon^{\beta l} + B\,\varepsilon^{-\beta l}}{K} = I_2 \tag{13}$$

$$A\left(1 - \frac{r_1}{K}\right) + B\left(1 + \frac{r_1}{K}\right) = E_0$$

$$A\,\alpha_1 + B = \frac{1 + \alpha_1}{2} E_0,$$

$$\text{where } \alpha_1 = \frac{K - r_1}{K + r_1} \tag{14}$$

$$A\left(1 + \frac{r_2}{K}\right)\varepsilon^{\beta l} + B\left(1 - \frac{r_2}{K}\right)\varepsilon^{-\beta l} = 0,$$

$$A\,\varepsilon^{\beta l} + \alpha_2\, B\,\varepsilon^{-\beta l} = 0,$$

$$\text{where } \alpha_2 = \frac{K - r_2}{K + r_2} \tag{15}$$

$$-B\alpha_1\alpha_2\,\varepsilon^{-2\beta l} + B = \frac{1 + \alpha_1}{2} E_0.$$

And finally,

$$A = \frac{-\alpha_2 \dfrac{1 + \alpha_1}{2} E_0\,\varepsilon^{-2\beta l}}{1 - \alpha_1\alpha_2\,\varepsilon^{-2\beta l}} \tag{16}$$

$$B = \frac{\dfrac{1 + \alpha_1}{2} E_0}{1 - \alpha_1\alpha_2\,\varepsilon^{-2\beta l}} \tag{17}$$

The usual methods of measuring insulation resistance employ a battery and measuring apparatus at the home end, with an insulated or open terminal at the distant end. An exact method, pre-

sented later, employs both an insulated and a short-circuited terminal at the distant end.

When $r_2 = \infty$

$$a_2 = -1 \tag{18}$$

and when $r_2 = 0$,

$$a_2 = 1 \tag{19}$$

Also, when $r_2 = K$,

$$a_2 = 0 \tag{20}$$

and

$$\left.\begin{aligned} A &= 0, \\ B &= \frac{1 + a_1}{2} E_0 \end{aligned}\right\} \tag{21}$$

By an inspection of (11) and (20) it will be seen that the physical interpretation of K is the outgoing resistance of an indefinitely long line, measured at the home end. Also, if the line be cut at any point and closed through a terminal resistance equal to K, the distribution of current and potential will be the same as in the indefinitely long line, and as though the terminal did not exist. The coefficients a_1 and a_2 are termed coefficients of reflection.

In the general case the outgoing resistance of a line is, from (10) and (11),

$$K_1 = K \frac{A + B}{-A + B} \tag{22}$$

$$= K \frac{1 - a_2 e^{-2\beta l}}{1 + a_2 e^{-2\beta l}}$$

$$= K \frac{e^{\beta l} - a_2 e^{-\beta l}}{e^{\beta l} + a_2 e^{-\beta l}}$$

When $r_2 =$ and $a_2 = -1$,

$$K_1 = K \coth \beta l. \tag{24}$$

When $r_2 = 0$ and $a_2 = 1$,

$$K_1^1 = K \tanh \beta l. \tag{25}$$

The exact method of measuring insulation resistance consists in measuring the current and the potential on the line at the home end,

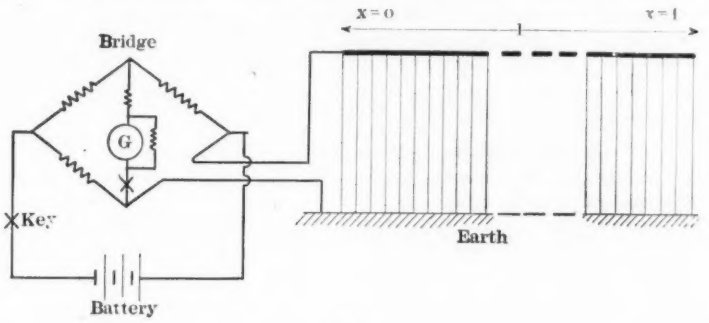


FIG. 1.

when the distant end is open or insulated and also when it is closed through zero resistance or short-circuited.

If K_1 is the measured resistance at $x = 0$, when $r_2 =$ and K_1^1 is the measured resistance when $r_2 = 0$, we have from (24) and (25):

$$\tanh \beta l = \frac{K}{K_1} = \frac{K_1^1}{K}, \tag{26}$$

$$K^2 = \frac{r}{g} = K_1 K_1^1 \tag{27}$$

and $$g = \frac{r}{K_1 K_1^1}$$

or $$R = \frac{K_1 K_1^1}{r} \tag{28}$$

where R is the insulation resistance in ohms per mile and r, K_1 and K_1^1 are expressed in ohms.

The bridge method consists in using the ordinary Wheatstone bridge for measuring K_1 and K_1^1, and the circuit employed is shown in Fig. 1.

When l and g are small, the approximate formula (29) may be used:

$$R = l K_1 \tag{29}$$

and only one reading is necessary. Readings should be taken with the positive and the negative poles of the battery to line. The average reading may be used in the formula. A marked discrepancy in the readings indicates a source of e.m.f. in the leakage paths. The objections to the method are the effect of earth currents or

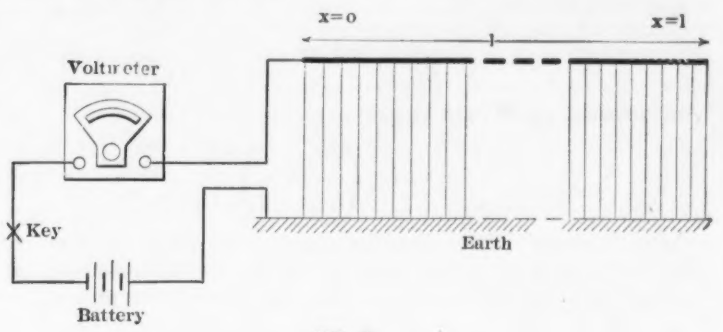


FIG. 2.

induced currents on the galvanometer and the time required to take readings.

The voltmeter method is simpler, quicker and requires less apparatus. It is necessary to know the voltage of the measuring battery and the internal resistance of the voltmeter. The procedure is the same as in the last method, readings being taken with $r_2 = \infty$ and $r_2 = 0$. The circuit is shown in Fig. 2.

Let the voltmeter reading be V_1 when $r_2 = \infty$, and V_1^1 when $r_2 = 0$. Then

$$K_1 = \frac{E_0 - V_1}{\frac{V_1}{r_1}} = \left(\frac{E_0}{V_1} - 1\right) r_1 \tag{30}$$

And

$$K_1^1 = \frac{E_0 - V_1^1}{\frac{V_1^1}{r_1}} = \left(\frac{E_0}{V_1^1} - 1\right) r_1 \tag{31}$$

where r_1 is the voltmeter resistance. Therefore, we have from (28):

$$R = \left(\frac{E_0}{V_1} - 1\right)\left(\frac{E_0}{V_1^1} - 1\right)\frac{r_1^2}{r} \tag{32}$$

It is interesting to note that the length of the line does not appear in the formula. It is necessary to know the line temperature unless r is measured on a very short section of the line at the time the readings, V_1 and V_1^1, are taken. Slight variations in temperature may be neglected; the necessary precision in the temperature, when r is computed rather than measured, may be obtained from the equation expressing resistance as a function of the temperature and the resistance at a standard temperature.

It sometimes occurs that there is additional resistance at $x = 0$, due to protective coils or lamps in the battery taps. In this case V_1 and V_1^1 must be corrected. If

$$r_1 = r_1^1 + r_1^{11} \tag{33}$$

where r_1^1 is the additional resistance and r_1^{11} is the voltmeter resistance, we have

$$V_1 = V\left(\frac{r_1^1}{r_1^{11}} + 1\right) \tag{34}$$

where V is the actual reading and V_1 the true corrected reading.

It often occurs that there is considerable cable between the measuring apparatus and the aerial line. In this case it is safe to assume that the cable leakage may be neglected and the cable resistance be

inserted as r_1^1 in equation (34). If there is leakage in the cable the case becomes that of two lines, having resistance and leakage of different magnitudes, connected in sequence. The general formulas (1) to (17) may be extended to cover this case, but the number of necessary readings would be increased.

If l and g are small the following approximation may be made, because the line drop, lr, is very small compared with the total leakage resistance, $\frac{1}{lg}$. When $r_2 = 0$, we have:

$$E_0 = V_1^1 + \frac{V_1^1}{r_1} lr = V_1^1\left(1 + \frac{lr}{r_1}\right) \qquad (35)$$

$$\frac{E_0}{V_1^1} - 1 = \frac{lr}{r_1} \qquad (36)$$

And substituting in (32) we get

$$R = lr_1\left(\frac{E_0}{V_1} - 1\right) \qquad (37)$$

where the length of the line appears, but the resistance does not. This is the well-known formula used in the method requiring only a single reading. The extreme conditions of insulation give

$$\left.\begin{aligned} V_1 &= 0 \quad \text{when } R = \infty \\ V_1 &= E_0 \text{ when } R = 0 \end{aligned}\right\} \qquad (38)$$

In measuring metallic circuits, it should be noted that r is twice the resistance of one wire per mile. If earth potentials are troublesome, in measuring the insulation resistance to earth in the exact method, the voltmeter should be read with no battery in circuit, in order to obtain a correction for the observations.

Measurements on a metallic circuit, from each wire to earth and from one wire to the other, should show that

$$(R_1 + R_2) \geq R_{12} \qquad (39)$$

if R_1 and R_2 are the insulation resistances to earth of the two wires, respectively, and R_{12} is the insulation resistance between them. R_{12} should always be measured with a battery to which there is no earth connection.

The number of variables in equations (32) and (37) make the work of plotting curves a laborious matter. Curves would be of little use because of the variation of r_1 in practical work. The calculation of a few actual cases will serve to illustrate the matter.

EXAMPLE I.

Take 50 miles of No. 12 (N.B.S.G.) copper wire; a voltmeter with a scale of 0 to 150 volts and a resistance of 15,000 ohms; a battery of 100 volts and negligible internal resistance compared with the voltmeter resistance.

$$\left.\begin{aligned} \text{Then } l &= 50. \\ r &= 5.13 \\ r_1 &= 15{,}000. \\ E_0 &= 100. \end{aligned}\right\}$$

Assume $R = 100$ megohms per mile,
or $g = 10^{-8}$ mhos per mile.
By calculation it is found that
$\beta = 0.0002265$ from (7)
$\beta l = 0.01132$,
$K = 22{,}650$ ohms, from (9)
$K_1 = 2{,}000{,}000$ ohms, from (24)
$K_1^1 = 256.5$ ohms, from (25)
$R = 100{,}000{,}000$ ohms, from (28)
$V_1 = 0.7444$ volt,
$V_1^1 = 98.32$ volts.

The error in (37) is negligible. The precision of V_1 is very poor, but for most cases R is so great that its effect is negligible, as far as transmission is concerned.

EXAMPLE II.

Take the wire of example I and assume
$R = 10$ megohms per mile,
or $g = 10^{-7}$ mhos per mile.
By calculation,
$\beta = 0.0007162$ from (7)
$\beta l = 0.03581$,
$K = 7{,}162$ ohms, from (9)
$K_1 = 200{,}100$ ohms, from (24)
$K_1^1 = 256.4$ ohms, from (25)
$R = 10{,}000{,}000$ ohms, from (28)
$V_1 = 6.974$ volts,
$V_1^1 = 98.32$ volts.

The error in (37) is negligible in this case also.

EXAMPLE III.

Take the wire of example I and assume
$R = 1.0$ megohm per mile,
or $g = 10^{-6}$ mhos per mile.
By calculation,
$\beta = 0.002265$ from (7)
$\beta l = 0.1132$,
$K = 2{,}265$ ohms, from (9)
$K_1 = 20{,}080$ ohms, from (24)
$K_1^1 = 255.4$ ohms, from (25)
$R = 1{,}000{,}000$ ohms, from (28)
$V_1 = 42.76$ volts,
$V_1^1 = 98.33$ volts.
$R = 1{,}004{,}000$ ohms, from (37)
The error in (37) is + 0.4 per cent.

EXAMPLE IV.

Take the wire of example I and assume
$R = 0.1$ megohm per mile,
or $g = 10^{-5}$ mhos per mile.
By calculation,
$\beta = 0.007162$ ohms, from (7)
$\beta l = 0.3581$,
$K = 716.2$ ohms, from (9)
$K_1 = 2{,}085$ ohms, from (24)
$K_1^1 = 246.1$ ohms, from (25)
$R = 100{,}000$ ohms, from (28)
$V_1 = 87.80$ volts,
$V_1^1 = 98.39$ volts,
$R = 104{,}300$ ohms, from (37).
The error in (37) is + 4.3 per cent.

EXAMPLE V.

Take 150 miles of No. 9 (B. W. G.) iron wire, with the same voltmeter and battery.

$$\left.\begin{aligned} \text{Then } l &= 150. \\ r &= 20. \\ r_1 &= 15{,}000. \\ E_0 &= 100. \end{aligned}\right\}$$

Assume $R = 1.000$ megohm per mile,
or $g = 10^{-6}$ mhos per mile.
By calculation,
$\beta = 0.004472$ ohms, from (7)
$\beta l = 0.6708$,
$K = 4{,}472$ ohms, from (9)
$K_1 = 7{,}638$ ohms, from (24)
$K_1^1 = 2{,}619$ ohms, from (25)
$R = 1{,}000{,}000$ ohms, from (28)
$V_1 = 66.25$ volts,
$V_1^1 = 85.13$ volts,
$R = 1{,}146{,}000$ ohms, from (37).
The error in (37) is + 14.6 per cent.

For short lines of copper the approximate method of (37) is sufficiently precise for most purposes. If the exact method of (32) is used the precision in R is poor if R is great, owing to the great difference between K_1 and K_1^1. For iron lines of moderate length and all very long lines the exact method of (32) should be used. For a given value of g, the error in (37) increases as r and l increase.

A method for the exact measurement of R and r has been given by Heaviside[1], and is of interest in this connection. The existence of concentrated leaks or non-uniformly distributed leakage renders the above theory inapplicable and the formulæ incorrect, and the theory of such cases belongs more properly to the subject of location of faults.

Direct escape into the atmosphere or the insulating dielectric is ordinarily negligible. The resistance of such paths may be calculated when the form and the specific resistance of the conductors are known, as shown by J. J. Thomson[2]. If the static capacity per

[1] "Electrical Papers," by Oliver Heaviside, vol. I, page 41, "On a Test for Telegraph Wires."
[2] "Elements of the Mathematical Theory of Electricity and Magnetism," by J. J. Thomson, page 312, §§ 196 and 197, on "Distribution of Current Through an Infinite Conductor."

unit length is C and σ is the specific resistance of the dielectric:

$$R = \frac{\sigma}{4\pi C} \qquad (40)$$

For a grounded line,

$$C = \frac{1}{2 \log \frac{2h}{r}} \qquad (41)$$

For a metallic line,

$$C = \frac{1}{4 \log \frac{d}{r}} \qquad (42)$$

And for concentric conductors,

$$C = \frac{1}{2 \log \frac{r_2}{r_1}} \qquad (43)$$

where r is the radius of a wire, h the height of a wire above the earth and d the distance between two wires. Therefore, we have, for a single wire with earth return,

$$R = \frac{\sigma}{2\pi} \log \frac{2h}{r} \qquad (44)$$

For a metallic circuit,

$$R = \frac{\sigma}{4\pi} \log \frac{d}{r} \qquad (45)$$

And for concentric conductors,

$$R = \frac{\sigma}{2\pi} \log \frac{r_2}{r_1} \qquad (46)$$

If σ is the resistance in ohms between parallel faces of a cubic centimeter of the insulation and the logarithms be taken to the base ten, expressions (44), (45) and (46) will be expressed in ohms per mile if multiplied by the constant,

$$1.431 \times 10^{-5} \qquad (47)$$

The value of the constant is small, but σ is ordinarily very great. The data on the subject of direct escape into saturated vapors, from suspended wires, is very meagre.

Elihu Thomson on Aeroplanes.

Considerable public interest has been shown in the remarks made by Prof. Elihu Thomson at the recent Walker dinner to Prof. Langley, on the subject of aeroplanes. Those remarks have been variously twisted and misquoted. Through the kind courtesy of Prof. Thomson we are now able to gratify the interest of our readers by presenting a revised abstract. Prof. Thomson says:

"I began by stating that I was very glad to be present on the occasion, and to do honor to Prof. Langley, whose work, in my opinion, had been of the highest importance to the problem of aerial flight; and by aerial flight I did not mean the moving about in the air of a dirigible balloon; for it seems to me that a gas-bag (however well arranged or braced) will always be at the mercy of the winds. If speeds of 100 to 150 miles an hour are ever to be attained in flight (and they should be attained to make aerial flight worth while) then the gas-bag must be left out of it, and we must rely upon the support of the air as a bird relies upon it.

"Looking at the subject from the standpoint of an engineer, it seems to me that when Dr. Langley constructed his original aerodrome which flew—the machine having within itself propelling machinery which could support itself in the air, and even rise in the air—he had solved the problem of aerial flight, from a mechanical standpoint. The small aerodrome of Prof. Langley (it was stated) had made numerous trips without difficulty; and surely it makes no difference to the problem whether it carried live freight or not. Who could doubt that a larger machine would have carried a man? It probably would have alighted with no greater difficulty. Nature has, in the bird, produced a mechanism for flying which it is not necessary that man should copy, any more than man should make his automobile with legs and feet, or his steamship with fins.

"The ideal machine must, however, have some of the bird's qualities. It will be noticed that the feathers of a bird have been evolved so that within these feathers a film of air may be carried by the bird, giving the result that in flying air is really moving upon air, resulting, as nearly as possible, in the absence of friction, which is the real obstacle calling for the expenditure of power. The feathers of the bird, also, by their yielding character and open structure practically reduce eddies to a minimum by conforming to the stream lines. The provision of the bird's feathers corresponds in function with that other most perfect covering for a fish, its body being covered with a gelatinous film, something which is as nearly like water as is possible, but is not washed off by the water; the result being that in the fish's motion there is almost (if not quite) a motion of one liquid upon another, with the elimination of much of the resistance encountered. Here again the long, tapering body of the fish, and the delicate tail and fins, result in conforming to the relative motion of the water alongside, and the elimination of eddies which consume power.

"The ideal machine for flying is necessarily, it seems to me, of the nature of a kite, which, instead of having a string to hold it up on the air, is pushed through the air by means of propellers, as in Prof. Langley's aerodrome and other similar machines. Obviously, it is here that a very light engine for its output in power will be needed. Dr. Langley has said that he has succeeded in obtaining an engine which did not require to weigh more than four or five pounds to the horse-power.

"It would be out of place here to speak of the commercial possibilities of the flying machine. It seems to me that it will naturally be a machine for emergency work; a most effective war engine, for example, and by a war engine I, of course, mean a peace engine. The more effective it is, the less likelihood there is of war being declared; and the menace of a sudden visit by a flying enemy would probably have the result of making those who declare war but do not fight the battles a little more cautious as to such declaration.

"We must not be impatient as to unavoidable accidents in the pioneer work of flying. There are undoubtedly difficulties yet to be overcome in launching the airship, and in alighting with it safely in all cases. A child may have the muscles and necessary organization permitting it to walk, but it will have to learn to walk; to co-ordinate its muscular actions and balance the nervous impulses. Even the young bird, on leaving the nest, is by no means an expert at flying until it has practised or learned the art. In the same way, given a machine which is controllable and which is able to fly, a machine perfect in every particular, it will be necessary even then for the operator to learn to manipulate it, just as one learns to manipulate a bicycle, i. e., to do the right thing, and not the wrong thing, on occasion.

"I have confidence that before many years we shall have operative machines which can traverse the air. I do not consider them, however, as substitutes for steamships, for freight trains, or even for passenger trains; their field being supplementary to these agencies, adding to our capabilities already mentioned another means of our getting about. The danger of collision in the air would, it seems to me, be less than on the surface of the earth, as there is room to pass not only to the right or to the left, but above and below. We are not confined to a road or a track, but we may count on two or three miles deep of air as the common highway. Man has accomplished so much in the past 100 years that it will not do to be pessimistic as to the possibilities of the future."

Electrical Words Wanted.

The *St. James Gazette*, of London, calls the attention of professional neologists to the pressing need of some new verbs. "We want," it says, "popular verbs for several operations introduced by modern science. The X-rays, the Finsen treatment for lupus, the operation of radium for cancer, and what not—what are the words for these? A man is guillotined or hanged; his leg is amputated; he is trepanned. What is it when he is rayed, Finsened, radiumed? We still want a wireless word. 'Marconigram,' which was suggested, seems to have died a natural death. What is the synonym for telephone when one speaks over the instrument to which a phonograph is attached? And have we finally agreed that 'motor' is the verb to travel by automobile?"

Speed-Torque Characteristics of the Single-Phase Repulsion Motor.

In opening his paper with the above title, read last week before the American Institute of Electrical Engineers, Mr. Walter I. Slichter said that for some months past he has been in charge of a series of experiments with various types of alternating-current motors, during which much attention was given to alternating-current commutator motors. The repulsion motor resembles very much a regular direct-current armature in an induction-motor field. The resemblance to the induction motor is carried still further in that there is no electrical connection between the primary and secondary. This makes it possible to wind the primary for a high line voltage, while the voltage of the secondary winding is chosen at such a value as may be commutated satisfactorily, since it is short circuited on itself through its brushes.

The motor has the same characteristics as the direct-current series motor; namely, maximum torque at starting, increasing torque with increasing current and decreasing speed, and comparatively constant efficiency through a wide range of speed. The maximum speed of the motor is limited only by the load and impressed voltage and has no relation to the synchronous speed.

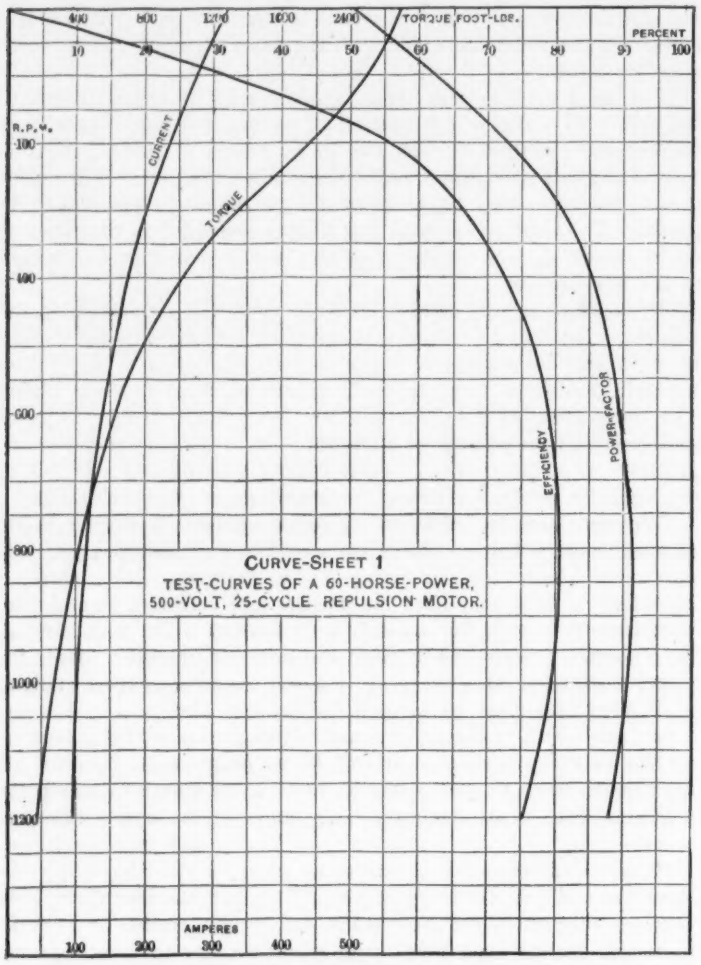


FIG. 1.—TEST CURVES OF 60-HP REPULSION MOTOR.

Due to the reactance of the motor circuits, the power-factor at starting is low and will be with any alternating-current motor; but in the repulsion motor a low power-factor does not mean small torque. On the contrary, the maximum torque occurs simultaneously with the lowest power-factor; that is, at starting. The power-factor of the repulsion motor rises very rapidly with the speed; it reaches a good value at one-third synchronous speed, and values near to 90 per cent. are obtained over a considerable range of speed. For this reason a large number of poles is not necessary and frequencies of 25, 40 and even 60 cycles may be employed.

The rotating conductors of the secondary cutting the primary flux, generate a leading e.m.f., which causes a leading current to flow therein and gives the high power-factor of the motor. In the plain repulsion motor, this leading current never reaches a value great enough to compensate entirely for the magnetizing and other wattless currents at available speeds, but the phenomenon is utilized to obtain unity power-factor in the compensated type by the addition of a second circuit. The inherently good power-factor of the repulsion motor makes it possible to use larger clearance between field and armature than is permitted in induction motors, thus greatly increasing its value in railway work where comparatively large air-gaps are necessary.

The curves given are partly from test and partly from calculation of motors having air-gaps on a side of ⅛ inch and more. The air-gap of corresponding stationary induction motors would be .040 inch and more. The efficiency, while not so good as in a direct-current motor, is yet very good, reaching values of from 80 to 85, including gear-loss for sizes ranging from 50 to 200 horse-power.

Commutation at normal speeds is inherently good, due to the revolving field. As the speed decreases, the current increases rapidly, producing a tendency to spark, but with the reduced voltage of starting the rush of current is limited to values within the range of good commutation, as in the direct-current motor. At higher speeds, ranging above one and a half times synchronism, the frequency of commutation becomes high and sparking appears.

The motor of Curve-Sheet 1 (Fig. 1) will start with 75 per cent.

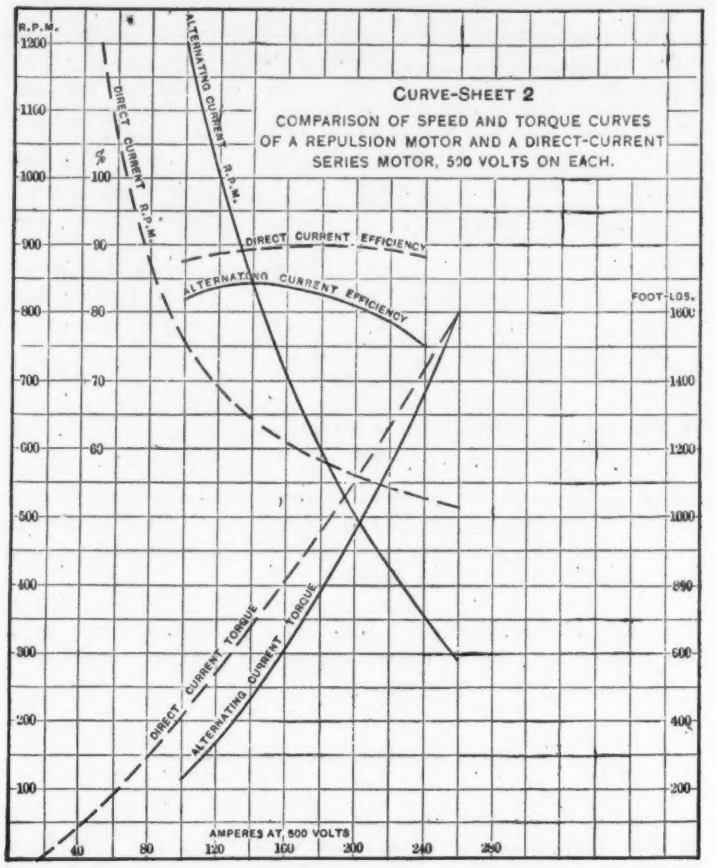

R.P.M.
ALTERNATING CURRENT R.P.M.
DIRECT CURRENT R.P.M.
DIRECT CURRENT EFFICIENCY
ALTERNATING CURRENT EFFICIENCY
FOOT-LBS.
DIRECT CURRENT TORQUE
ALTERNATING CURRENT TORQUE
AMPERES AT 500 VOLTS
CURVE-SHEET 2
COMPARISON OF SPEED AND TORQUE CURVES OF A REPULSION MOTOR AND A DIRECT-CURRENT SERIES MOTOR, 500 VOLTS ON EACH.

FIG. 2.—CURVES OF REPULSION AND DIRECT-CURRENT MOTORS.

of full voltage and twice full-load current with no trouble from sparking. As these curves are prepared upon a railway-motor basis, and full-load current will produce a rise of 75° C. after one hour's run, the ability of the repulsion motor successfully to commutate overloads is equal to that of the direct-current series motor; in fact, better, due to the short-circuited commutator which makes flashing-over impossible.

Curve-Sheet 1 (Fig. 1) shows the characteristics of a repulsion motor plotted with revolutions per minute as a base. These curves are taken from tests on a 60-hp, 25-cycle, 500-volt motor; they show the rapidly rising efficiency and power-factor and the large torque at starting. The starting torque is 2,300 ft. lbs., with an input of 325 amperes, and the normal torque during acceleration, 450 ft. lbs. at 750 revolutions and 125 amperes. Thus the starting torque is five times normal and the starting current 2.6 times normal; or the torque per ampere at starting is 1.92 times what it is at normal speed, should occasion demand the full starting capacity of the motor.

This statement gives an idea of the steep speed-characteristics of the motor, which are even better shown in Curve-Sheet 2 (Fig. 2). The

full lines refer to a later type of repulsion motor and the broken lines to a standard direct-current series railway motor; these curves are plotted in the usual way with current as a base. This shows that the torque increases more rapidly with increasing current in the repulsion motor than in the series; and conversely that the speed of the repulsion motor increases more rapidly with decreasing current than in the series motor. Efficiency, including gear-loss, is given and is 84.5 per cent. at the maximum for the alternating-current motor. This motor was designed with the steep speed-characteristics for acceleration work, while the motor of Curve-Sheet 4 (Fig. 4) is designed for constant-speed running and has not such steep curves but better constants at light loads.

The characteristics show the repulsion motor to be admirably adapted for acceleration work, the efficiency of acceleration being higher than in direct-current work, due to the possibility of obtaining fractional e.m.f's with alternating currents without introducing the dead resistance losses of the direct-current system of control.

This is shown in the curves on Curve-Sheet 3 (Fig. 3) which gives the acceleration curves from test of a 25-ton car equipped with two 60-hp repulsion motors. The full lines indicate the repulsion motor characteristics and the broken lines those calculated for a direct-current equipment. The gearing is chosen for the same free running speed, 33 miles per hour, the same average acceleration and the same distance covered in sixty seconds. For the direct-current motor the curve of wilowatts input, miles per hour, and miles traveled, are given as calculated; and for the alternating-current motor the kilovolt-ampere input, kilowatt input, miles per hour, and miles traveled, from test.

The repulsion motor remains on the controller only sixteen seconds and the direct-current motor 25 seconds. The maximum power taken by the direct-current motor is 70 kw and by the repulsion motor 61 kw or 67 kilovolt-amperes. At the end of 25 seconds, the total kw-hour input in the two cases is .375 for the direct current and .30 for the alternating current. At the end of 60 seconds both cars have covered a distance of .039 mile and have reached practically the same speed of 32.5 miles per hour, the kw-hour input being .72 for the direct current and .685 for the alternating current.

By comparing the areas of the kilowatt curves in the two cases the gain or rather the saving by the use of the alternating current is readily seen. It is also worthy of note that the volt-ampere input of the alternating-current motor is least at starting; that is, the line current is least. As this is the time at which the power-factor

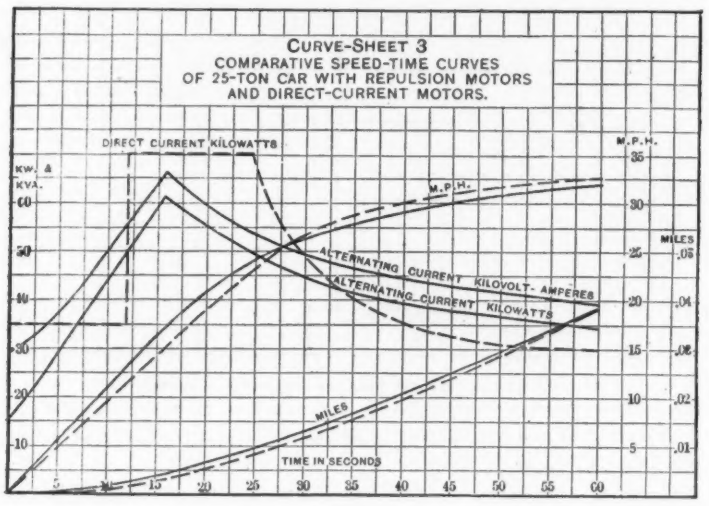


FIG. 3.—COMPARATIVE SPEED-TIME CURVES OF 25-TON CAR WITH REPULSION AND DIRECT-CURRENT MOTORS.

is lowest, it is seen that the effect of the low power-factor on the regulation of the system is much modified by the small value of the current.

Curve-Sheet 4 (Fig. 4) shows the calculated characteristics of a 175-hp railway repulsion motor having an air-gap of .15 inch and wound for 1,500 volts and 25 cycles. The efficiency, including gear-loss, is 85 per cent. at the maximum and the power-factor is 93. Such a motor is designed for heavy, slow-speed locomotive work, which is probably one of the most promising fields for the alternating-current motor. It is readily seen how well it is adapted for freight haulage by the fact that the efficiency of 85 per cent. is attained at a speed as low as 500 revolutions, thus permitting a speed of 12 to 15 miles per hour, with a good gear reduction.

Thus the repulsion motor is well adapted for acceleration work as well as for efficient running at light loads, and having good constants at low speeds is well adapted for freight haulage at low speeds.

The curves given in the paper all refer to the simple repulsion motor, the theory of which is given in a paper read at the same meeting by Mr. C. P. Steinmetz, printed elsewhere in abstract in this issue. There are many variations of the repulsion motor, more or less complicated, from which a better power-factor and even a

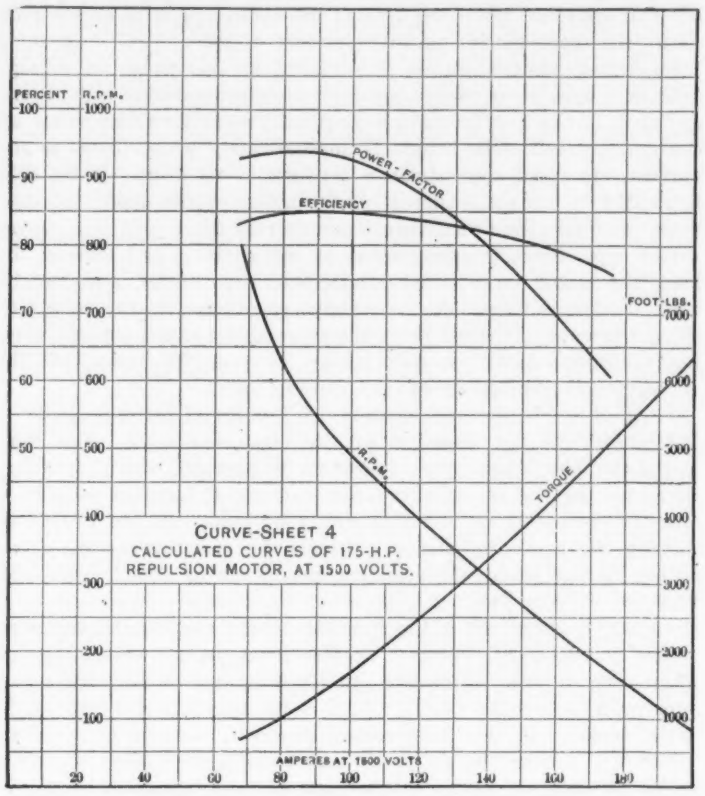


FIG. 4.—CALCULATED CHARACTERISTICS OF A 175-HP, 1,500-VOLT REPULSION MOTOR.

better efficiency have been obtained in test, but Mr. Schlecter said that a description of these various schemes with their characteristics would require sufficient space to warrant a distinct paper and intimated that such a paper would be presented before the Institute at some future date.

Electric Traction in Cuba.

Mr. Max J. Baehr, the United States Consul at Cienfuegos, Cuba, says: "Cienfuegos has railway communication with Habana, Matanzas, Cardenas, Sagua la Grande and Caibarien on the north coast, with Santa Clara in the interior, and thence, since the completion of the new Cuban Central Railroad, with Santiago.

"A project is now under consideration by local and American capitalists for the construction of an electric railway extending from this city into the interior, a distance of 30 miles or more, which would give rapid transit between Cienfuegos and several important villages in the sugar-producing belt, these towns now having very inadequate communication with this port. I am credibly informed that a company has been organized to carry the project into effect, that a charter has been applied for and obtained, and that only a short time will elapse before the beginning of active work on the grading of the road. If this enterprise is carried to fulfillment, as seems reasonably certain, it will not only give employment to a large number of laborers who now find steady work only during the sugar-grinding season, but will contribute in no small degree to the material upbuilding of this section of Cuba.

"For the information of American dealers in electric and railroad supplies, I will state that the name of the company undertaking this work is the Cienfuegos, Palmira and Cruces Electric & Power Company, with headquarters at Cienfuegos."

The Repulsion Type of Alternating Current Motor.

In a paper presented last week before the American Institute of Electrical Engineers, entitled "The Alternating-Current Railway Motor," Mr. C. P. Steinmetz, after referring to the early work of the late Rudolph Eickemeyer with the single-phase alternating-current motor, gave in extenso the theory of the Thomson repulsion type of motor.

In introducing the paper Mr. Steinmetz said that for electric railway work a motor is required which maintains a high value of efficiency over a wide range of speed. That is, the torque per ampere input at constant impressed voltage must increase with decrease of speed, the speed increasing with decrease of load.

In electric motors, torque is produced by the action of a magnetic field upon currents flowing in an armature movable with regard to the field. If then the field is constantly excited—shunt motor on constant potential—the torque is approximately proportional to the current, the speed approximately constant at all loads. If the field is excited by the main current of the motor—series motor on constant potential—the field strength and thereby the torque per ampere varies approximately proportional to the current, and thereby the load, the whole torque approximately to the current, and thereby load, the whole torque approximately proportional to the square of the current and the speed inversely proportional to the current, leaving saturation out of consideration. That is, the motor has the characteristic specified above for a railway motor.

Since the direction of rotation of the direct-current motor is independent of the direction of the impressed e.m.f., with laminated field the direct-current motor can be operated with alternating-currents. By the use of alternating currents it becomes possible to transfer current from circuit to circuit by induction, and instead of passing the main-line current through the armature of the alternating-current motor, the armature circuit can be closed upon itself and the current induced therein as transformer secondary by a stationary primary coil in the main circuit surrounding the armature.

The condition of operation of the direct-current motor type on alternating current is, however, that the current in field and armature reverses simultaneously. This is by necessity the case in the series motor. In the shunt motor, however, the armature current as energy current should be in phase with the impressed e.m.f., while the field current as magnetizing current lags nearly 90°. To bring it back into phase, Stanley tried condensers in series in the field circuit, but failed, due to the impossibility of neutralizing the self-induction of the field which varies with the commutation and the frequency, by the negative self-induction of the condensers, which varies with the frequency in the opposite direction. The solution of the problem has been found in the use of polyphase systems, by utilizing for the field excitation the e.m.f. in quadrature with the armature currents acted upon by the field magnetism. Mr. Steinmetz says that as he has shown elsewhere, the polyphase induction motor can be considered as a development of the direct-current shunt motor for alternating-current circuits, and indeed has all the shunt motor characteristics regarding speed, torque, etc. As a railway motor the induction motor has therefore not been exploited, although it has been strongly recommended in those very few cases where it appeared good engineering. Experimental work with polyphase induction motor railways has been carried on continuously since 1893.

While in the early days of alternating-current motor development, all other engineers were industriously developing the type with shunt motor characteristic, Rudolph Eickemeyer, of Yonkers, alone was far-sighted enough to realize the absolute necessity of the series motor characteristic for railway work and undertake the development of the single-phase alternating-current series motor. Mr. Steinmetz added that he had the good fortune at that time to be associated with Mr. Eickemeyer.

As was pointed out by Kapp, in 1888, the power factor of the alternating-current series motor is inherently low, since the same magnetic flux which induces, proportional to the frequency of rotation, the e.m.f. of useful work in the armature conductors, induces in the field coils an e.m.f. of self-induction, proportional to the frequency of alternation, thereby giving the armature the same number of turns as the field (which is more than permissible in good practice, since good practice requires weak armature and strong field). Even at synchronous speed the e. m. f. of rotation of the armature would still only be equal to the e. m. f. of self-induction of the field; and the power-factor, allowing for an additional self-induction of the armature, would be below 70 per cent. This probably deterred the other engineers from considering the alternating-current series motor.

Eickemeyer solved the difficulty by designing the armature with a number of turns several times greater than the field (25 to 7 in the first motor built) and neutralizing the armature self-induction and reaction by a stationary secondary circuit surrounding the armature at right angles electrically to the field circuit (the "cross-coil," as he called it), and either short-circuited upon itself or energized by the main current in opposite direction to the current in the armature.

In January, 1891, Mr. Steinmetz tested the first motor of this type, a bipolar motor with the following constants:

Field: Two coils of 14 turns No. 10 B. S. wire, connected in parallel. Armature: 24 coils of four turns each of No. 12 B. S. wire. Secondary circuit: Two coils of 18 turns each of No. 10 B. S. wire connected in parallel.

At 100 cycles and 150 volts impressed e.m.f., this motor gave

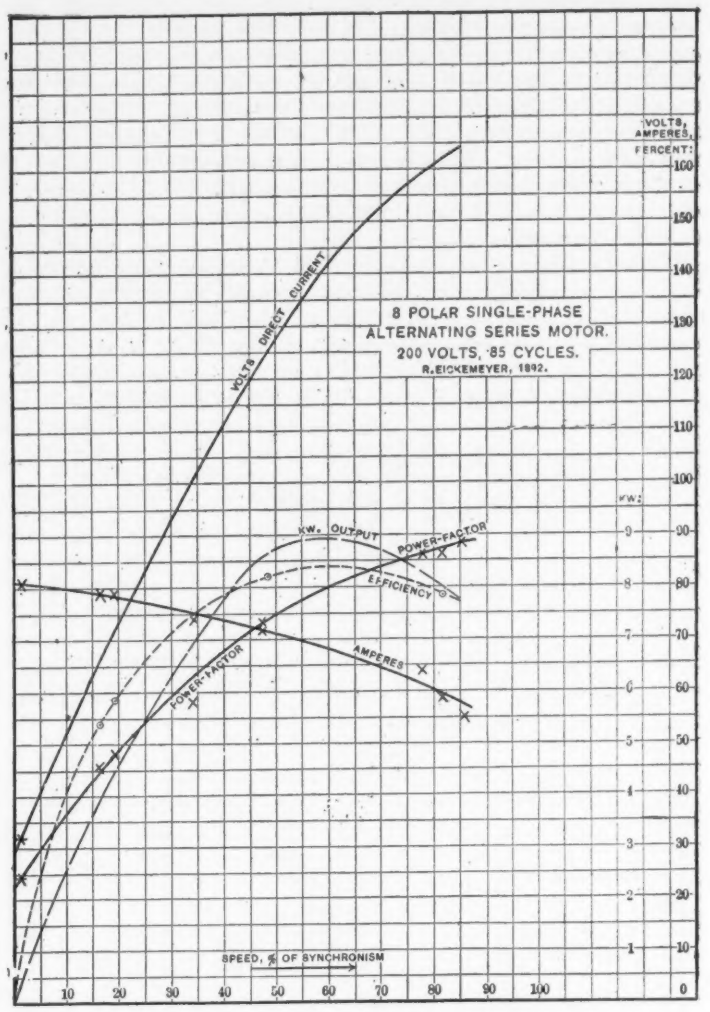


FIG. 1.—TEST CURVES OF EICKEMEYER MOTOR.

a three-fourths synchronous speed, and its starting current at 150 volts and 70 amperes.

Current: 45 amperes. I^2R: 400 watts. Hysteresis and eddy currents: 900 watts. Total output, including friction: 4,000 watts.

Hence the efficiency was 75.5 per cent., and the power factor, 79 per cent.

As a bipolar motor with the very high frequency then used, the speed, 4,500 revolutions at three-fourth synchronism, was undesirably high, so immediately an 8-polar motor was built. In this, solid copper rings were used as secondary circuits surrounding the armature and neutralizing its self-induction, with an effective copper section more than four times that of the armature conductors. The ratio of armature series turns to field series turns was about 4. This motor was tested in 1892. The record of tests is given in Fig. 1, the observed values being marked on the curves. For comparison on this sheet is also given the direct-current voltage required to operate this motor at the same speed and current.

As will be seen, when approaching synchronous speed, the power-

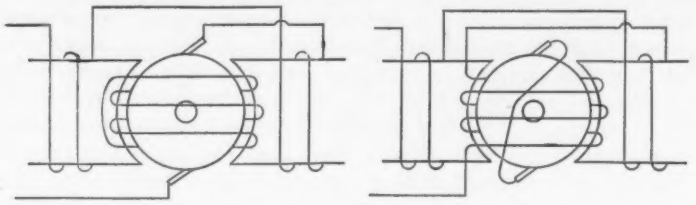
factor is nearly 90 per cent. The commutation was fair at 85 cycles, the highest frequency at which the factory engine was able to drive the alternator, and attain at 33 cycles.

A number of railway motors of this type were designed. The great difficulty, however, was that during these early days 125 to 133 cycles was the standard frequency in this country, 60 cycles hardly considered, and 25 cycles not yet proposed.

The efficiency of this alternating-current series motor is slightly lower than that of the same motor on direct-current circuit, due: (1) To the hysteresis loss in the field. (2) The hysteresis loss in the armature core, which is of full frequency up to synchronous and of still higher frequency, the frequency of rotation, beyond synchronism. (3) The I^2R loss in the short-circuited secondary conductors surrounding the armature.

As will be seen, to make the alternating-current series motor practicable, the transformer feature must be introduced, by having its armature as primary circuit closely surrounded by a short-circuited secondary circuit, as shown diagrammatically in Fig. 2.

Instead of closing the stationary circuit upon itself as secondary



FIGS. 2 AND 3.—DIAGRAMS OF ALTERNATING-CURRENT SERIES MOTOR.

circuit and feeding the main current into the rotating armature as primary circuit, mechanically the same results would obviously be obtained by using the stationary circuit as primary energized by the main current and closing the armature upon itself as secondary by short circuiting the brushes and thereby keeping the main current and the line potential away from the armature, as shown diagrammatically in Fig. 3. This introduces the great advantage of reversing the sign of the uncompensated part of the armature self-induction, so that it is subtractive, which results in an essential improvement of the power-factor, especially at low speed.

This is shown in Fig. 4, where with the speed as abscissas, in per cent. of synchronism, are plotted the power factor of the Eickemeyer compensated series motor of Fig. 1, of ratio armature to field = 4, and the power-factor of one of the first railway repulsion motors, of ratio armature to field = 3.5.

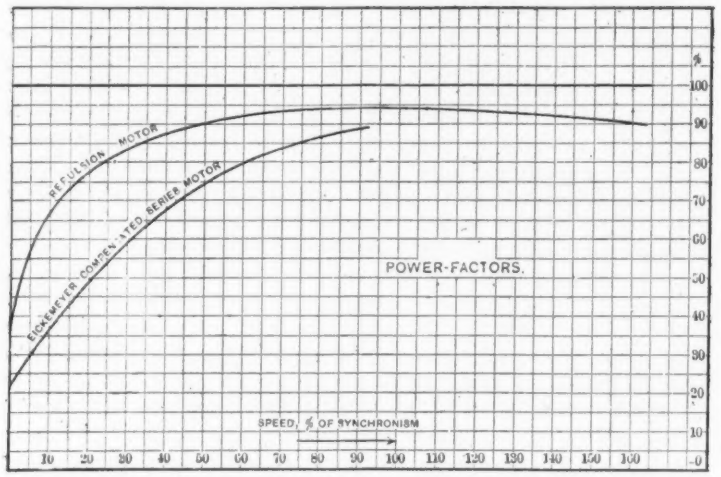


FIG. 4.—POWER FACTOR CURVES.

The compensation of the armature self-induction in Fig. 3 is based on the feature of the transformer that primary and secondary current are in opposition to each other. The secondary current of the transformer, however, lags slightly less than 180° behind the primary current; that is, considering it in the reverse direction, is a leading current with regard to the primary current. The current in the armature in Fig. 3, is, therefore, a leading current with respect to the line current, and so not only does not add an additional lag but reduces the lag caused by the self-induction of the field-exciting coil.

This motor then consists of a short-circuited armature surrounded by two coils at right angles with each other and connected in series, as illustrated in Fig. 5; the one A_2, parallel with the effective armature circuit, acting as primary of a transformer to induce the secondary armature current; the other, A_1, the field exciting coil. The ratio of turns of the coils, n_2 to n_1, is the ratio of ef-

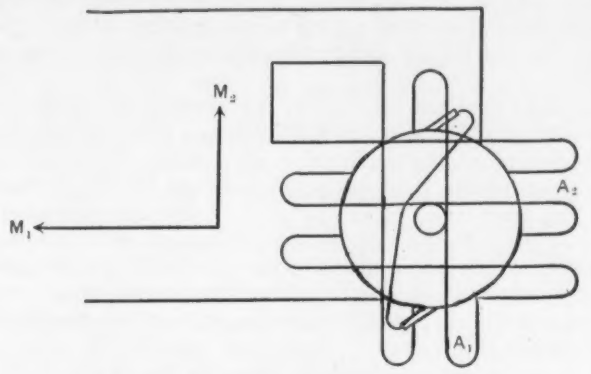


FIG. 5.—DIAGRAM OF EICKEMEYER MOTOR.

fective armature series turns to field turns, as discussed before. Obviously, these two coils can be replaced by one coil at an angle with the position of brushes as shown in Fig. 6, and the cotangent of the angle of the axis of this coil with the position of the brushes is above ratio; that is, the smaller this angle the greater is the ratio of armature to field turns; that is, the better the power-factor of the

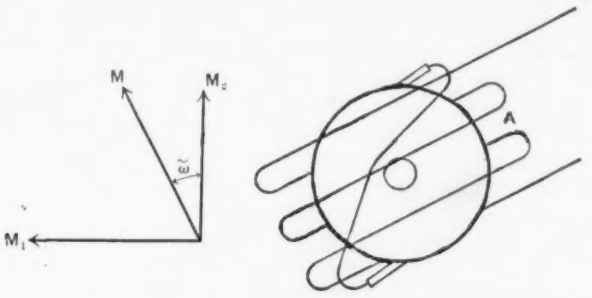


FIG. 6.—DIAGRAM OF THOMSON REPULSION MOTOR.

motor. This motor is Professor Elihu Thomson's repulsion motor.

In the armature an e.m.f. is induced by the alternation of the magnetic field, M_2, of coil A_2, proportional to M_2 and to the impressed frequency and in quadrature with M_2, and an e.m.f. is induced by the rotation through the magnetic flux M_1 of coil A_1, proportional to M_1 and to the frequency of rotation and in phase with M_1. These two e.m.f's must be equal and opposite, since the armature is short circuited (neglecting the resistance and self-inductive reactance of the armature) and at synchronism. Therefore M_1 and M_2 are equal and in quadrature with each other; that is, in the armature of the motor, Fig. 5, and therefore of the repulsion motor, Fig. 6. At synchornism a uniform rotating field exists and the hysteresis loss in the armature core is therefore zero at synchronism and at other speeds proportional to the difference between speed and synchronism; that is, to the slip, just as in the polyphase induction motor, while in the motor, Fig. 2, the hysteresis loss in the armature core is proportional to the impressed frequency or the frequency of rotation, whichever is the higher frequency. The hysteresis loss of the repulsion motor is, therefore, lower than that of the same motor as compensated series motor.

In Fig. 6 the magnetic flux in line with the brushes, which does not induce e.m.f. by rotation but only by alternation, is denoted by M_2; the magnetic flux in quadrature with the brushes which induces e.m.f. in the armature by its rotation but not by the alternation of the flux, by M_1; and the magnetic flux in the axis of the primary coil A, which is much nearer to M_2 than to M_1, since a good power factor requires a small angle ω, by M. Mr. Steinmetz then shows mathematically that M_1 and M_2 are in quatrature in phase and the ratio of their intensity is inversely proportional to the ratio of speed to synchronism. Fig. 7 shows the two quadrature components, M and M_2 of the magnetic field of the repulsion motor for $\omega = 16°$ and $M = 1.0$.

That is, in the repulsion motor an elliptically rotating field exists which becomes circular; in other words, a uniformly rotating field, at synchronism. Below synchronism the component, M_1, which

induces e.m.f. by the rotation of the armature is greater than M_2, the more the lower the speed. The flux M interlinked with the primary coil is, however, nearer to M_2 and therefore below synchronism, especially at low speeds. The magnetic flux which induces e.m.f. by the rotation of the armature and so represents the useful work, is greater than the magnetic flux which interlinks with the primary coil and so gives the lag of the primary current. This accounts for the high power-factor of the repulsion motor at low speeds.

The paper then proceeds to give a theoretical investigation of the repulsion motor considered as a transformer, the secondary of which is standing at a constant angle ω with regard to the primary, so that motion results from the repulsive thrust existing between primary and secondary.

One of the deductions is that, unlike the plain series motor, which can never return power into the line, the repulsion motor when reversed becomes a generator, consumes mechanical power as brake and returns electric power into the line, even at low speeds. Experiment verifies this feature.

In discussing the mathematical theory developed, it is stated that

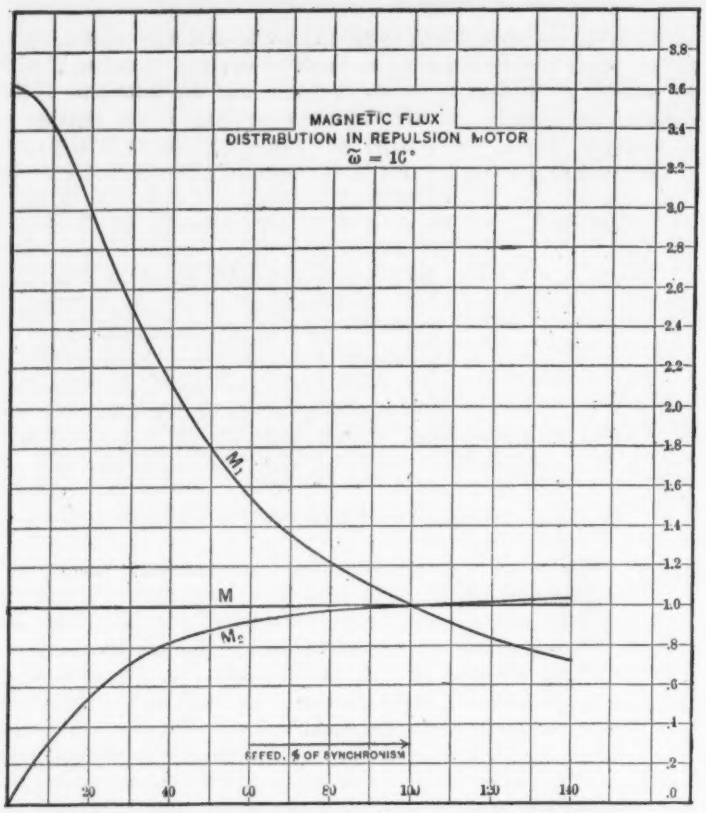


FIG. 7.—MAGNETIC DISTRIBUTION IN REPULSION MOTOR.

the primary exciting, primary self-inductive and secondary self-inductive impedances have been assumed as constant. While this is approximately the case in the ordinary induction motor, it is not the case with the repulsion motor which works over a wide range of magnetic flux densities.

With increasing load and thereby increasing current and decreasing speed, magnetic saturation is approached and causes a decrease of the impedances, which has to be taken into consideration in predetermining the characteristic curves of such a motor. Furthermore the different component magnetic fluxes are affected differently by saturation. The flux, M, interlinked with the primary coil is approximately constant and therefore affected by saturation only indirectly, while the flux, M_1, at right angles to the line of polarization of the secondary coil is approximately proportional to the load and so reaches saturation at high loads, and the impedances become thereby different in the different directions of the magnetic structure.

The m.m.f's in the investigation were treated as vector quantities, independent of their distribution around the periphery of the armature. This distribution, however, is different with the different m.m.f's. The m.m.f. causing the effective flux, M_1, is due to a zone of the primary winding within the angle $\pm \omega$ from the axis of the secondary coil, hence nearly a concentrated winding, which gives a flat-topped flux distribution, while the flux, M_2, in the direction of the axis of the secondary coil is that of a distributed winding or peaked. For the same m.m.f the effective flux, M_1, is, therefore, greater than the effective M_2. Taking this into consideration, gives the motor somewhat better characteristics than calculated above. Owing to the different wave shapes of the fluxes, M_1 and M_2, they are affected differently by saturation. The flat-topped flux M_1 reaches saturation at a much higher value, but then over the whole range, while the peaked flux M_2 shows the effect of saturation at a lower value but then gradually, by a rounding off of the peak. In the repulsion motor it is therefore not sufficient merely to consider the resultant m.m.fs. as vectors but their distribution in the air-gap and the effect of saturation must be taken into consideration in the calculation and design of the motor. Mr. Steinmetz adds that an exhaustive investigation of this point has been made by his assistant, Mr. M. Milch, and may be communicated at a later date.

The secondary circuit of the motor has been considered as the seat of two e.m.fs. induced respectively by the rotation through flux M_1 and by the alternation of flux M_2. These e.m.fs., however, have no separate existence. At synchronism, for instance, the magnetic field is an approximately uniformly rotating field and, therefore, no e.m.f. is induced in the armature conductors except that required to overcome the resistance. The secondary frequency varies with the load and thereby the secondary self-inductive reactance which we assumed as constant in the preceding discussion. Mr. Steinmetz says this is best taken into consideration by a theory developed by his former assistant. Mr. S. Sugiyama, of Japan. The primary impressed alternating m.m.f. of the current I is resolved into two component m.m.fs. of half intensity, revolving synchronously in opposite directions. If now a = the ratio of speed to synchronism, the two oppositely revolving components of I revolve with regard to the secondary system with the speeds $(1 - a)$ and $(1 + a)$ respectively. The same consideration applies to the secondary m.m.f. I_1, and in the secondary system we then have induction at two frequencies, $1 - a$ and $1 + a$, of which the former becomes zero at synchronism. That is, at synchronism the secondary current in the armature conductors is of double frequency, similar as in the ordinary single-phase induction motor. At other speeds it is the superposition of two currents of the frequencies $1 - a$ and $1 + a$, respectively. This theory more closely allies the repulsion motor with the ordinary induction motor. Using the same values of secondary impedance, Z_1 for both components, obviously leads to identically the same equations as given in the preceding.

The complete investigation of the repulsion motor must also take into consideration the current flowing in the armature coil during the moment where the coil is short circuited by the brushes passing from commutator segment to segment. The m.m.f. of this short-circuit current of commutation is at right angles to the axis of secondary polarization of current I_1, hence has the angle of brush-shaft — $(90 - \omega)$. A corrective term must, therefore, be applied, taking this phenomenon into consideration, essentially of the character of a repulsion machine with negative or generator brush-angle of $(90 - \omega$ and very high effective secondary resistance. This term is very small or negligible at speeds up to a point somewhat beyond synchronism but becomes noticeable at speeds considerably above synchronism, due to the decrease of the main current at these speeds. The main effect of this phenomenon is that the power-factor of the motor instead of increasing indefinitely with the speed up to 100 per cent at some very high speed (and then decreasing again slightly with leading current), reaches a maximum somewhere between 90 and 97 per cent., according to the constants of the motor, and then very slightly decreases with increasing speed, as is shown in the curve of the power factor of a repulsion motor in Fig. 2.

Cables as Heartstrings.

At the dinner of the Pilgrims' Society, January 29, the London and New York contingents banquetted on the same night; here at Delmonico's, and in London at the Carlton. The Commercial Cable wire was run into both rooms and friendly messages freely exchanged. In London, the unique feature of the evening consisted in the installation by the cable company of two old grandfather's clocks, one showing English and the other American time which enabled Mr. Choate, Lord Salisbury and the others to keep an eye on the progress of the New York banquet. The usual cable company's clock, with a red hand showing American time, was placed between the two clocks. The tables were also decked with telegraph wires and miniature poles.

Women in the German Telegraph-Telephone Service.

In a recent report on the subject of the employment of women in the telegraph and telephone service in Germany, Mr. J. F. Monaghan, United States Consul at Chemnitz, says:

"While women were employed in the postal and telegraphic service of France and England as early as 1820 and 1830, Germany did not make a trial of feminine service until 1874. The main circumstance that led to the employment of women at that time was a scarcity of available men. When later the administrations of the postal and telegraphic services were combined under one head, a general discharge of the women who had obtained positions in the service followed, largely, so it is reported, because Postmaster-General Stephan, who wielded a determining influence at the time, was irreconcilable in his opposition to the employment of women in the postal and telegraphic service. Hence, all women engaged in the telegraphic service were removed, and only a comparatively small number of those employed in the postal service reluctantly retained as a further experiment. Three years later, in 1876, these also were separated from the service of the Empire.

"The successor of Stephan, Postmaster-General Podbielski, was favorably disposed toward the employment of women. He laid considerable weight upon the successful experience with women in foreign countries, especially in the United States. Through his support and influence women were again introduced into the postal service, though only in limited numbers and purely for the purpose of further trial. The result was quite as satisfactory as had been expected, and since then the number of women in the German postal, telegraphic and telephonic service has been rapidly increasing, until to-day they comprise an invaluable and indispensable part of the same.

"In all post offices of the third class women assistants are appointed by the postmasters of the place, under strict limitations, however, of government regulations respecting age, character and education. Such assistants must be of sound health, certified to by a government medical examiner. They must be entirely free from all deformities, of stainless character, from 18 to 30 years of age, and must possess a good common school education. The highest salary that may be paid to such assistants at third-class post offices is 500 marks ($119) per year. In post offices of the first-class and at railroad post offices women may be engaged for service as typewriters or similar duties only. All women assistants have the character of government officials (Beamteneigenschaft), which means that on their withdrawal from the service after faithful, competent work during a prescribed number of years they have a claim to a pension (Ruhegehalt), under the law of the Empire, if their circumstances are adjudged such as to require it. Instead of being qualified to occupy only a certain class of specified positions, as was found to be the case in the German postal service, women are privileged to take any positions whatever in the telegraphic service, subject at all times to the above-enumerated regulations respecting age, character and education. They have a similar claim to a pension as those engaged in the postal service and in all respects are similarly employed, privileged and discharged.

"At the present time 4,000 women are employed in the telephone service of the German Empire. In Berlin alone 1,000 women are engaged. These positions are so popular and the number of applications is so large that the number of accepted and qualified women whose names have been registered in the order in which they were considered is so large as to supply occupants for any possible vacancies that may result in the course of the next few years. Only physically strong girls are admitted to the service. They must possess a good character and be of respectable families. They must be between 18 and 30 years of age and either unmarried girls or widows without children. Every applicant must possess an education equivalent to graduation from an elementary school (Elementarschule). In making the application for a position it is necessary to produce a birth certificate, school certificate, certificate of conduct (Leumundszeugnis), in which are registered all praise or dissatisfaction expressed by previous employers of the person in question, and a brief biography. The latter must have been written and constructed solely by the applicant. The written consent of the father or guardian is also necessary. Some time after the application, accompanied by all the required papers, has been filed notice is sent to the applicant to appear for an examination, which embraces ordinary questions of arithmetic, German and geography.

"After successfully passing the examination the applicant is sent to an official medical examiner, who must certify as to her physical and nervous soundness, and especially as to the condition of her lungs and nerves.

"Having successfully acquitted herself in all the foregoing tests, the applicant is now ready to begin a period of practical preparation. This work as an apprentice covers from three to four weeks, and during the time the learner receives no salary. Having satisfactorily completed her period of practical study, the applicant is ready to enter upon a regularly paid position. Since, as was already stated, the number of applicants is always extremely large, a number of months or even a year or two may pass before a vacancy occurs. A position being open, the applicant cannot enter upon the same if she has in any way, in the meantime, spoiled her record or failed to preserve a stainless character. She must also, at the time of her employment, be living with her parents, or in some other respectable place free from all question.

"The daily hours of employment vary from six to eight; sometimes Sunday work is required. The employee must, immediately after being engaged, begin her contributions to the sick fund (Krankenkasse beitreten), and in case she succumbs to sickness or injury she continues to draw three-fourths of her regular salary and receives free medical treatment. Her pay to begin with is 2.25 marks (53.5 cents) per day. After two years of satisfactory service this is raised to 2.50 marks (59.5 cents) per day. After two additional years—that is, after having been four years in the service—her pay is raised to 3 marks (71.4 cents). If, after service for several more years, the girl has shown herself capable and unusually diligent, she may be appointed as supervisor (Aufsichtsdame), with an annual increase in pay of 100 marks ($23.80).

"After ten years of faithful service another advantage is added in the form of appointment with full claim to a pension (Anstellung mit Pensionsberechtigung). After being thus engaged, her salary amounts to 1,100 marks ($261.80). This salary is then increased every three years by the amount of 100 marks ($23.80) until it amounts to 1,500 marks ($357). This is the highest salary that a woman can draw in the German telephonic service. It is sufficient to insure a comfortable existence to the employee, though to an American the amount may seem somewhat small, even for an exceedingly plain living. It must be remembered that the German women living in Germany who belong to this class of wage earners can live with considerably less expense and with much greater comfort than would be possible in the United States.

"In England the salaries of positions of this kind are much better paid. Girls are admitted to the service at 15 years of age. During the first years, while they are 'girl clerks,' they receive from 800 to 900 marks ($190.40 to $214.20). When they receive a permanent position as 'women clerks' their salary is increased to 1,100 to 1,200 marks ($261.80 to $285.60). After twelve years of faithful service they receive the considerable salary of 2,400 to 2,500 marks ($571.20 to $595). The best women are even appointed to positions as chief supervisors or assistants in first-class offices, with a salary of 10,000 marks ($2,380)."

A Canadian Electrothermic Commission.

The commission recently appointed by the Canadian Government to investigate all existing electrothermic processes of manufacturing iron and steel in Europe, sailed from New York January 23 on the Cunard Line steamer *Lucania* for Liverpool. The commission is made up of Dr. Eugene Haanel, superintendent of mines in Canada; Mr. C. E. Brown, electrical engineer; Mr. Nystrom, draughtsman; Mr. Thomas Cota, secretary, and a steel expert and photographer who will join the party in England.

The commission will visit Sweden, France and Italy, and it is probable that some four months or more will be used in carrying on the work of investigation and research. For years the rich iron mines of Canada have remained dormant with abundance of water power available on all sides. But it is now believed by the Minister of the Interior in Canada, and by financiers, that the work of this commission will pave the way for great industrial prosperity in the Dominion.

Nowhere in America has the electric furnace been commercially applied to the manufacture of iron and steel, but in Europe much has been done in this direction. There the possibilities of the furnace in the metallurgy of iron and steel are well recognized, and much good work has been done.

New Telephone Patents.

IMPROVED LINE APPARATUS.

There was a time when all details of telephone pole line construction were entirely in the hands of the line foreman. There was little apparatus especially designed to meet his needs and he, therefore, had to makeshift with the various materials at hand in overcoming the difficulties, and in solving the problems met. This is now, however, all changed, as the requirements for poles, arms, guys and wires are well understood and the assembling of them into a line is prescribed in comprehensive specifications. These latter, however, are continually undergoing a revision to keep pace with the inventors, who are at frequent intervals developing improved accessories.

We have at hand for present consideration four patents covering line accessories, which have been lately invented. One of these patents describes a new method of "tying-in" line wires. The preferred scheme employs a tie wire, the middle portion of which is flattened out into a ribbon. This ribbon portion is wrapped in a close spiral around the wire to be secured, at the joint where the line wire passes the insulator. The two ends of the tie wire are then passed around the insulator and secured by twisting them together on the side opposite the line wire. This invention is the work of Alexander Kline, of Jersey City, N. J.

Another patent concerns an apparatus for anchoring guys. For many years the only anchor known was a rock, or log buried in the earth. The labor of digging is a matter of such trouble and expense that a great deal of ingenuity has been displayed in developing an anchor which can be driven, and a number of such are now upon the market. The present patent describes an anchor of this type comprising a shank with pivoted wing pieces, which assume a position at right angles to the shank in case any attempt is made to pull it up. The only improvement claimed is a shaping of the butts of these wings so as to concentrate all stresses upon their pivots. W. G. Beach, of Grandlake, Kan., is the patentee of this anchor.

Two cable suspension clips form the subjects of the remaining line material patents. These are both the work of one inventor, O. C. Hoffmann, of Chicago. Both follow the general design of the most successful clips of to-day, consisting of a strip of sheet zinc to surround the cable and a suspension hook of wire so formed that by intertwining the end of the zinc strip with it the

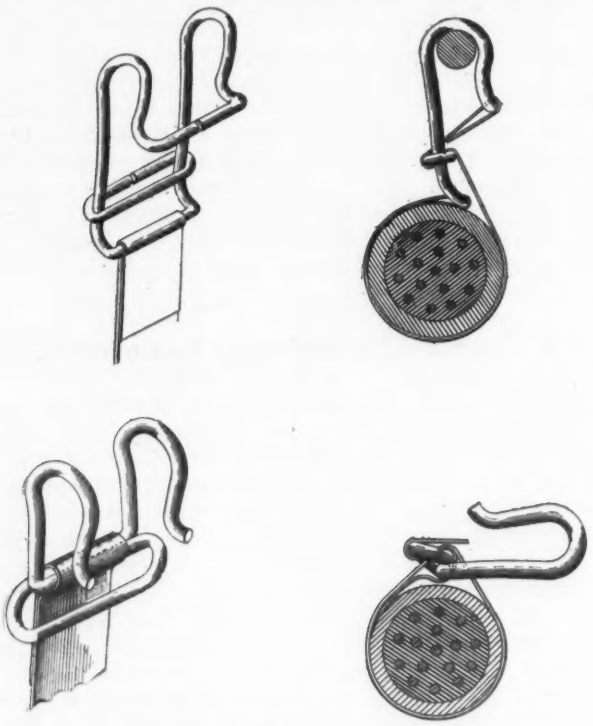


FIG. 1.—HOFFMAN CABLE CLIP.

whole forms a secure fastening. The exact method of using the clips will be better understood from a glance at Fig. 1 than from any description. The clip in the lower part of the figure is shown just ready to hook over the messenger strand.

REMODELING BRANCH TERMINAL SWITCHBOARDS.

Before the advent of the common battery switchboard the most approved form of board for large central offices was the multiple bridging or branch terminal board. Many of these are doubtless in use to-day and in a state of preservation such that the improvement in service with the central battery board does not seem of sufficient weight to warrant their rejection. Several suggestions as to methods of remodeling such switchboards so that much of their apparatus and wiring might be retained, and yet providing a central battery service, have been put forward as a solution of the difficulty; but heretofore a practical trial has proved all such suggestions to have been faulty in conception. A new idea in this direction, which appears encouraging, is disclosed in a patent issued to M. C. Rorty, of Dedham, Mass., and assigned to the American Telegraph & Telephone Company. The remodeled system contemplates the use of the drops and jacks, both answering and multiple, together with practically all of the magneto system wiring associated with them—a great saving. The connecting cord circuits must, however, be reversed, although the keys and plugs are suitable for reuse. In Fig. 2 is shown the remodeled system in diagram, in which will

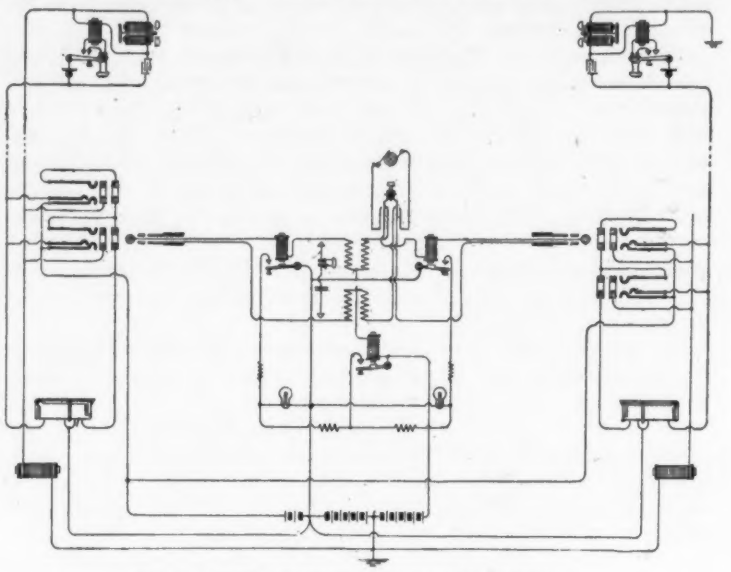


FIG. 2.—RORTY SWITCH AND SIGNAL SYSTEM.

be recognized at once the standard Bell common battery subscriber's station set, and the standard bridging line circuit. The only changes in this latter are the insertion of a battery and retardation coil in the drop circuit. The battery, of course, causes the drop to fall as soon as the line circuit is closed by the release of the subscriber's hook switch. The retardation coil serves to balance inductively the effect of the earthed line drop coil, which, as there is no cut-off device, remains legged to ground at all times. The cord circuit is novel only in the provision of a relay in the battery supply to the repeating coils, which, through its contacts, controls the supervisory lamps, so that these may glow only when the plugs are in the jacks. The busy test is quite similar to that of the standard bridging switchboard.

NEW APPARATUS.

An improvement in magneto bells has been made by A. M. Knudson, which consists essentially in providing a base plate upon one side of which the gong posts are secured and from the side of which the ringer frame and magnets project. This arrangement makes the bell complete in itself, and it may be removed from its containing box as a whole. The base plate serves as an escutcheon for the opening in the box through which the bell is to be inserted, and thus the whole gives a neat appearance. The Kellogg Switchboard & Supply Company have obtained Mr. Knudsen's patent by assignment.

A rather unusual piece of apparatus is a plug with an automatic switching device contained within its shank, which has been designed and patented by F. D. Pearne, of Chicago. It is evidently Mr. Pearne's idea to use this switching device in the plug to control the supervisory lamp circuit of modern switchboards and to save thereby one of the relays of the cord circuit in two-wire switchboards. The automatic switch consists of mercury traveling in a glass tube carrying sealed-in terminals. It is doubtful if any material gain will result from its use, in the first place because the connecting cords must contain conductors to lead to and from it, and secondly because of the untrustworthy characteristics of mercury switches in continual use.

Fig. 3 shows a new form of dust-proof relay. This, it will be noted, follows in many details some of its predecessors, the chief novelty lying in the use of an intermediate lever member between the contact springs and the armature. It is impossible to predict just of

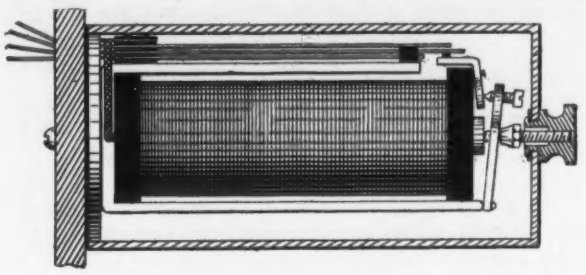


FIG. 3.—DOWNS RELAY.

what advantage such an arrangement will prove, but a multiplication of parts always raises some doubt. The patent for this relay has been granted to J. P. Downs, of Cleveland, Ohio, and has been assigned to the North Electric Company.

SIGNALING SYSTEM.

Everyone has observed the appreciable interval of time required for the filament of an incandescent lamp to cool after the current is shut off, and it is only reasonable to suppose that there must be some corresponding though shorter interval ordinarily required for the filament to attain its brilliancy. Mr. H. P. Claussen, of Chicago, feels that this retarded lighting may result in a failure of the signal of an incandescent switchboard signal lamp, in case its controlling circuit be rapidly closed and opened by a rapid vibration of the switchhook or other circuit-closing device. He, consequently, in endeavoring to overcome any such difficulty, has arranged and patented a signal lamp circuit such that a large rush of current far above the normal current of the lamp flows in the first moment of the closing of its circuit. This sudden abnormal current lights the lamp at once, after which the current is reduced automatically to normal by a relay wired in the lamp circuit and controlling a shunt about the lamp. The American Electric Telephone Company has been assigned the patent for this method of causing lamps to glow.

AUTOMATIC SWITCHING MECHANISM FOR PRIVATE LINES.

Two patents have been issued to U. S. Jackson, of Boston, describing an automatic switching mechanism for use on party private lines, which operate without any central office. Each station is provided with a spring motor, which becomes locked at such times as the line is in use. This precludes any interruption to conversation between two stations from the selective currents of other stations, and as the talking circuit of each set is also controlled by existing conversations, no interruption or listening can be done. The selection of desired stations is performed by impulse currents from a circuit-breaker driven by the spring motor and controlled by the calling party. These currents cause the operation through an electromagnet, and a ratchet and pawl revolve the selecting commutators at all stations, arresting their motion in position for the signaling of the desired station only. Such an arrangement, unmodified, of course, permits one station to hold up the whole line. The necessary modification to prevent this has, however, been provided in the form of a switch upon the receiver of the calling station. This switch must be depressed at all times during conversation or the line will be automatically returned to the normal condition, releasing all stations.

COMBINED ALARM AND TELEPHONE SYSTEM FOR POLICE SERVICE.

In many cities the patrol boxes for the use of the police have for a number of years been provided with alarm signals and in others with telephone instruments. It is now proposed to combine these systems in the same boxes, using the same wires to the central station. This new system provides the usual alarm apparatus to send in automatically the number of the box from which an office is reporting. It provides an answer-back signal signifying the receipt of the telegraphic report, this signal being a hum on the line produced by a buzzer at the central, and to be noted by the office by the use of the telephone receiver; and lastly it provides an alarm signal to notify the officer that he is to use the telephone to receive orders or other information. W. E. Decrow is the patentee, he having assigned his patents to the Gamewell Fire Alarm Telegraph Company.

Wilkinsburg Electric Club.

Organized in the spring of 1902, the Electric Club, of Wilkinsburg, Pa., has at present a membership of more than 500, handsome quarters and a most efficient organization for carrying out the technical purposes which form no small part of the object of the body. Evidently much thought has been given to the organization of the club in order to properly balance its several features, and particularly to render it of the greatest use in every possible direction to its members, who are mostly employees of the Westinghouse Electric & Manufacturing Company. The accompanying illustrations give an idea of the manner in which the club is housed. Its main rooms occupy the whole of a floor of a large building in Wilkinsburg, Pa., with additional space on another floor for games and smoking rooms. The illustrations show the assembly room, which has a seating capacity of about 300 and is used for general and technical lectures, meetings

FIG. 1.—ASSEMBLY ROOM.

of the local section of the A. I. E. E., weekly meetings of the East Pittsburg Drawing Class, and for Saturday evening entertainments and dances. Another illustration shows the reading room, and a third one of the three class rooms.

The organization is very thorough, consisting of a board of direc-

FIG. 2.—READING ROOM.

tors and seven committees, namely, house, library, excursion and research committees, and committees on lectures, section and class work. Every Saturday evening entertainments are held in the club room under the auspices of the ladies' committee. Several times a month technical papers are read by members of the Westinghouse staff and other authorities on the subjects treated. During the month of last February, for example, Prof. W. S. Franklin read a paper on the "Choice of Signs in Polyphase Systems and Ratings of Polyphase Transformers"; Mr. L. M. Aspinwall, of the Westinghouse Company, one on "Systems of Control for Electric Street Railway Work"; Mr. Paul M. Lincoln a paper entitled "Some Features of

Niagara Falls Power Work"; Mr. W. K. Dunlap one on "Some Problems in Construction Work," and Mr. W. J. Beck a paper on the "Testing of Iron and Steel for Electrical Purposes." Classes have been organized for the benefit of the members of the club who have not received a technical education, to enable them to study elementary electrical theory as applied to the apparatus manufactured by the Westinghouse Company. At present there are two classes, one meeting every Tuesday and the other every Friday evening. There are also ten sections which meet to discuss apparatus, shop methods and technical subjects. These sections cover the subjects of direct current, alternating current and railway work, transformers, testing,

FIG. 3.—ONE OF THE CLASS ROOMS.

detail apparatus, road engineering and switchboard, alternating-current work and transformers, having each two sections.

An idea of the activity of the club may be gathered from the following calendar for the spring of 1903:

On Mondays there was a general or technical lecture; on Tuesday evenings a meeting of Class A and Sections 1, 4 and 8; on Wednesday evenings, Drawing Class lectures and meetings of Sections 2, 3 and 5; on Thursdays a general or technical lecture; on Fridays, meetings of Class B and Sections 3, 6 and 7, and on Saturday evenings social meetings with an excursion the third Saturday of each month. The local section of the American Institute of Electrical Engineers meets each month at the club room, all members of the club having the privilege of attending. In the evening drawing classes there are about 100 students, divided into four sections, instruction being given on Mondays, Tuesdays, Thursdays and Fridays. We gather the above information from a handsome brochure issued by the club, which contains illustrations of the club quarters, and information in detail as to the personnel and work of the body.

Recent Electrochemical Developments.

ELECTRIC FURNACES.

In a patent granted on January 26, Mr. Henri Harmet, of St. Etienne, France, who is well known from his work in the electrometallurgy of iron and steel, describes a form of electric blast furnace which contains a lower fusion zone and an upper reduction zone. Electrodes extend into the fusion zone from the outside. The ore, with an excess of reducing carbon, is charged into the top of the furnace and current is supplied through the electrodes so as to form a local fusion zone. There is at this place an excess of heat which would be wasted, if it would pass downward with the molten metal. To prevent this, the inventor proposes to take away the gas escaping at the top of the furnace and carry it downwards with the aid of a fan or blower into the fusion zone, whence it is pressed upwards. The heat of the fusion zone is thus diffused upwards, and the gas when coming into contact with the incandescent coke adjacent to the fusion zone is converted into carbon monoxide, which, when passing through the charge, creates a reduction zone above the fusion zone. The reduction of the charge thus precedes the fusion, and the operation is continuous.

A patent granted to Mr. R. C. Contardo, of Sèvres, France, relates to the design of an electric furnace, the hearth of which has a curved surface, with electrodes above the same. The arch above the hearth consists of two downwardly inclined surfaces, while parallel with the same there are side walls so as to form two inclined flues through which the ore is passed downwards. The heat radiated from the arcs upwards is thus utilized to preheat the charge passing through the flues. The gases developed during the reduction are led away, and the inventor proposes to utilize their caloric effect in gas engines driving generators which are to furnish current for the operation of the furnace.

BATTERY INVENTION.

A patent granted to Messrs. C. P. Elieson and V. de Bobinsky, of Paris, France, relates to the construction of a storage battery plate with a central conducting core of lead, and strips of this lead alternately flat and corrugated, attached at one end to each side of the core and free at their other end. A strengthening frame, comprising upper and lower cross pieces of insulating material and india rubber ligatures, bind the whole together, but allow a free lateral expansion of the thin lead strips.

Radium in Medicinal Springs.

Note was made in these columns recently of the fact that radium in appreciable quantities has been found in the famous springs at Bath, and it is stated on high scientific authority that there is little doubt there are large quantities of it deep down in the earth. Further details are to hand from England. For some time Prof. Dewar has, at the expense of the Royal Society, collected the gases that rise in the largest and best-known of the Bath springs—the King's Bath—and the result of his analysis revealed the fact that the rare element helium existed in the Bath waters.

The existence of helium led to the belief that something more of scientific interest might be found in the deposits in the tanks and pipes at the three springs, inasmuch as Sir William Ramsay recently discovered that helium is slowly evolved from radium. A quantity of deposit from the New Royal Spring was obtained, and was sent to the Hon. R. J. Strutt, son of Lord Rayleigh, who made a careful investigation of the material submitted to him. The result of his investigation he has just communicated in a letter to the Bath authorities.

"I have found," says Mr. Strutt, "that the deposit contains radium in appreciable quantities, though I am sorry to say not enough to pay for extraction. I think there can be little doubt that the helium of Bath owes its origin to large quantities of radium at a great depth below the earth's surface. A little of this radium is carried up by the rush of hot water, and it is found in the deposit. My experiments promise further interesting developments."

This letter was read at a meeting of the Bath City Council by Mr. T. Sturge Cotterell, who added that Mr. Strutt had since written that by "appreciable quantities" he meant quantities such that its presence "may quite easily be detected." But the percentage found was less than in the ore from which radium is at present obtained. About ninety-eight gases are given off by the Bath waters, and Prof. Dewar examined samples of them all. The deposit which Mr. Strutt examined is one of countless peculiar features of the Bath waters. It settles on walls and the bottoms of tanks and corrodes pipes, being like mud of a rich orange color. When dry it is orange-colored powder, but duller in hue and very fine in substance. Settling on stone or projections, it hardens and assumes the appearance of coral or fungus.

The estimated yield of the Bath springs is a million tons of water per annum, and this includes very considerable solid deposits, mainly sand. While the radium is too small in quantity for extraction now, better methods of extracting it are hoped for at Bath.

Pacific Cables.

A bill has been introduced in the United States Senate, at Washington, by Senator Mitchell, authorizing the North American Telegraph & Cable Company to operate telegraph lines or cables between the shores of Alaska and Washington, in order to reach the Aleutian Islands, Siberia, Manchuria, China, Japanese Empire and the Philippine Islands.

January Meeting of the American Institute of Electrical Engineers.

In calling to order the regular monthly meeting of the American Institute of Electrical Engineers, which was held in the rooms of the Chemists' Club, New York, January 29, President Arnold announced that at the meeting of the directors in the afternoon action was taken which will insure harmonious co-operation between the Institute and the International Electrical Congress to be held in St. Louis next September. He referred to the annual dinner of the Institute to be held February 11 at the Waldorf-Astoria, and said it promised to be one of the most successful affairs of the kind that the Institute has yet given. In introducing the papers of the evening, President Arnold referred to the great change in sentiment in this country during the past two years on the alternating-current railway motor question, there being at the present time three systems advocated by men in this country and several in Europe.

In presenting his paper, an abstract of which is printed elsewhere, Mr. C. P. Steinmetz said that his purpose was to give a brief history or review of the development of the alternating-current railway motor as far as he can speak from personal experience. The occasion also serves to bring to the notice of those who have not specially followed this line of development the work of Mr. Eickmeyer, now dead ten years, which at the time was hardly noticed, but which with the development of electrical engineering has become of great importance, and indicates how far ahead of his time Mr. Eickmeyer was in his investigations.

Mr. Schlicter, in introducing his paper, which is reprinted elsewhere, said that it is intended largely to be a practical illustration of the motor which Mr. Steinmetz discusses generally and theoretically, and also to offer in curves some experiments made with the motor.

The discussion of the two papers of the evening was participated in by Messrs. Arnold, Lamme, McAllister, Lincoln, Mershon, Armstrong, Lundell, Lyford, Wagner, Torchio, Steinmetz and Schlicter. The remarks of Messrs. Lamme and Steinmetz were of considerable length and will be reprinted in full in a subsequent issue, being here merely epitomized.

Mr. Lamme defined series alternating-current motors as a type in which the field varies automatically with the change in voltage in the armature. This type can be subdivided into two classes, one of which may be called a straight series motor, the armature being in direct series with the field, and the other a transformer series motor. This latter can again be subdivided into two classes, one with the transformer external to the motor and the other with the transformer in the motor. The latter is the repulsion motor and has the characteristics of the series motor. For a straight series motor to have a good power factor, it is necessary to make it as far as possible non-inductive and have the armature voltage relatively low in comparison with the field voltage. The direction in improvement, then, is to increase the armature and decrease the field turns, or increase the armature turns as compared with the field turns. The alternating-current motor of either the repulsion or straight series type is designed to run at low saturation, and at low saturation it will have torque characteristics better than those of an ordinary direct-current series motor, though the latter will give as good torque characteristics with an unsaturated field. The entire proportioning of a repulsion motor for good power factor depends upon high ampere-turns in the transformer element and low ampere-turns in the exciting element.

A transformer type of motor should have poorer starting properties than a straight series motor, and this is indicated by the curves shown in the papers and by tests made. This means that for the same current at starting slightly less torque is obtained than with the series motor, and for the same torque there is a greater ampere input, which may amount to as much as 30 per cent. Comparing the material in the two motors, it would seem that slightly less material is required for the straight series than for the transformer type. In the armature the series motor carries only the working current, while the repulsion motor carries the working current plus the magnetizing current; but as the latter is not in phase and ordinarily may be a small component, it will not be of great importance. In any of the present types of motors so far devised there is a very considerable loss in the short-circuited coil at starting and this will be slightly greater in the repulsion than in the straight series motor. The difference may not be enough to amount to anything, but it is in favor of the straight series motor. As to the flashing of this type of motor, the point has been mentioned that the repulsion motor cannot flash, and Mr. Lamme points out that the same is true of the straight series type.

Mr. Lamme said there is one point connected with the question of high power factor which should not be ignored, which is that a rather high power factor accompanies machines of rather low efficiency, and this is true of all kinds of alternating-current motors. The low efficiency, in fact, to a certain extent, accounts for the high power factors, and the power factor can be increased in any motor by increasing the losses; therefore, in considering the question of high power factors the efficiency should be looked at also. Referring to comparisons between the acceleration of the direct current and the alternating-current motor, Mr. Lamme said that he thought part of the superiority of the latter should be attributed to the unsaturated condition of its working; and that any direct-current motor if working with an unsaturated field will give better accelerating conditions and more economical starting than a saturated motor. The reason for saturating the direct-current motor is to give it lighter weight, while in alternating-current motors we normally work to an unsaturated condition.

Prof. A. S. McAllister referred to a statement of Mr. Steinmetz that the repulsion motor may also be operated as a generator, and he gave a simple graphical method to show why such a motor acts as a generator, and also a graphical method for representing some of Mr. Steinmetz's equations.

Mr. Steinmetz said he was pleased that Mr. Lamme agreed with him concerning the relations of the repulsion motor, the plain alternating-current series motor and the alternating-current series motor fed by a transformer; and he was also pleased that Mr. Lamme had come to the same conclusion at which Mr. Eickmeyer and he had arrived in their early work, namely, that the only way to make an alternating-current series motor operate at reasonably satisfactory power factor is to combine as high armature reaction as possible with as low field excitation as possible, then increasing the ratio of armature to field magnetism, thus eliminating useless current. He did not consider it correct, however, to assume that the armature of an alternating-current motor can be made non-inductive. There is an ultimate limit between the ratio of armature reaction and field excitation, beyond which one cannot go without again losing. Referring to the power factor of the repulsion motor, he said that it is inherently high. In the ordinary induction motor one can use large magnetic saturations, though not nearly the saturations used in the direct-current motor. As to differences in weight and efficiency of the direct series and repulsion motor, if one and the same motor were experimented with at times as a straight series and at times as a straight repulsion motor, a wrong conclusion on this point might be arrived at. A motor which is a good series motor will make a very poor repulsion motor and vice versa. One cannot take one and the same motor and run it first as one and then as the other and draw general conclusions, because the transformer feature introduced requires redesigning of the motor.

Mr. Paul M. Lincoln, referring to a remark of Mr. Steinmetz to the effect that the repulsion motor, when reversed, becomes a generator, and can then be used for braking or returning power into the line, said that the same is true of the straight series motor, as shown in experiments in which a wattmeter indicated that the motor was returning power to the line, and on one occasion, when an airbrake failed, the car was stopped by the motor.

Mr. Mershon asked a number of questions concerning practical points in connection with the repulsion motor, to which Mr. A. H. Armstrong replied. He said that the repulsion motor can be designed to operate on direct current good enough to help through a town along the right-of-way; but that a good repulsion motor and a good direct-current motor cannot be combined in the same structure any more than can a good straight series motor—it is necessary to make sacrifice in one feature or the other.

As to the e.m.f. of the repulsion motor, they can be built for 2,000 or 3,000 volts on the field without the use of transformers, though in this case some advantages in motor control would be lost; however, motors of high potential would hardly be used in service calling for frequent stops, and without frequent stops the small difference in efficiency at starting would have no appreciable effect on the general efficiency of the system as a whole. As to the weight of alternating-current and direct-current motors, the former will weigh some more, but just how much added weight there will be is at present not known. As to the weight of the rest of the

equipment, with the case of a high potential motor with 3,000 volts direct on the field, the control equipment would not weigh very much more; with low potentials, however, there would be the added weight of the transformer in addition to the rest of the apparatus.

President Arnold said that the practicability of using high voltages has been pretty thoroughly demonstrated in practice abroad; in Italy, for example, 3,000-volt motors have been operated for two or three years and there has been no report of deterioration of insulation. In reply to a question from Mr. Lundell, Mr. Steinmetz said that comparing the present alternating-current motor of the plain series or repulsion type with the highly developed direct-current motor, the former is somewhat less efficient and weighs somewhat more. He considered, however, that the difference is altogether less than should be anticipated considering the short time of development of one and the long period of development of the other. While at present and perhaps for some years to come the alternating-current railway motor will, as a new type of apparatus, be handicapped by somewhat lower efficiency and somewhat greater weight, Mr. Steinmetz does not consider this inherent in the motor and does not consider it impossible that they will come to a quality with, or even in some cases superior to, the direct-current motor.

Mr. O. S. Lyford having made an inquiry as to the relative dimensions of direct and alternating-current motors, Mr. Schlicter said that a 100-hp motor could be used with a 33-in. or 36-in. wheel. Mr. Lamme added that his company is now building 150-hp motors, which will go in on 33-in. wheels, and that they have concluded that they can put 200-hp motors on 36-in. wheels.

In reply to a question from Mr. H. A. Wagner, Mr. Steinmetz said that the repulsion motor takes more copper and less iron than the direct-current series motor. The straight series motor will have a smaller armature diameter than the repulsion motor, probably larger external diameter, more iron and less copper, but in general he does not expect there will be any important difference between the two types.

Mr. Philip Torchio said he considered that the present traction question is one of distribution, not only for the ordinary kinds of electric railways, but for large trunk lines where heavy traffic is to be handled, and consequently the question of the motor itself is not of paramount importance, provided apparatus can be obtained that will do the work. President Arnold added that if we get an alternating-current motor which will do the work as well as the present series motor, though nothing has been gained, by virtue of the advantage of distribution, a great step forward will have been made. In point of fact the alternating-current and direct-current motors have almost the same efficiency, and with the former is gained the great advantage of distribution inherent in alternating currents. This will enable us to construct electric railways at less first cost than we can do to-day with the direct-current system, and will open up new fields to electric traction.

When and How Incandescent Lamps are Used.

By Mortimer Norden.

The following data has been collated by me showing the yearly consumption of current per 16-cp lamp on the circuits of a large central station company, giving the yearly average of current used in kw-hours. I believe that many of your readers will be interested to see this analysis at the time of the twenty-fifth anniversary of the incandescent lamp. The data represent ten plants all operated by the one company:

Totals of Average Consumption, Showing Yearly Consumption per 16-cp Lamp Connected.

		Lights.	Kw-hours.
1	Green house	54	1.33
24	Colleges and schools	2,863	5.70
127	Churches	11,616	7.75
3	Parks	416	9.24
1343	Residences	40,095	10.73
64	Dentists' and physicians' offices	1,066	15.10
344	Factories	21,936	15.53
8	Signs	365	18.48
14	Public halls	1,781	18.81
6	Dressmakers	111	20.24
1	Grain elevator	24	20.75
102	Municipal buildings, hospitals, armories and city halls	14,654	24.79
104	Clubs and lodge rooms	7,391	24.82
147	Nine o'clock stores	4,433	26.35
401	Seven o'clock stores	17,623	26.55
449	Eight o'clock stores	13,228	27.10
137	Livery stables and stables	1,775	29.56
26	Eleven o'clock stores	624	30.01
287	Office buildings and offices	7,363	30.65
10	Theatres	10,581	32.13
9	Road houses	305	32.70
45	Banks and insurance companies	3,322	33.80
11	Ten o'clock stores	339	38.34
2	Cold storage companies	158	40.82
4	R. R. terminals and docks	854	42.14
180	Drug, confectionery and cigar stores	4,370	42.44
640	Saloons, restaurants and concert halls	17,592	43.62
327	Six o'clock stores	23,584	45.61
22	Wholesale butchers	1,012	46.92
25	Commission dealers	518	48.06
8	Twelve o'clock stores	170	52.44
3	Steamship docks	2,293	61.71
5	Hotels	1,099	65.
23	Railroad stations	909	118.98
2	All night stores	410	218.06
4904	customers,	214,934	
		Grand average	27.28

Statistics of Export Trade.

The figures of 1903 in United States export and import trade have already been noted in these pages, and now further details as to this record year are obtainable. For the twelve months ending December 31 the exports of domestic manufactures amounted to $421,453,915, against $410,650,967 in December, 1902, an increase of $10,802,948. The increase for December alone was thus more than one-half of the total increase for the calendar year. In 1902 many of the leading articles of export fell behind the record for the previous calendar year. The most notable decline was in the exports of cotton cloths, which fell off about $7,000,000. Exports of copper manufactures fell off about $2,000,000, and exports of vegetable oils about $3,000,000. The most notable increase was that of about $5,000,000 in exports of agricultural machinery. Other important increases were $3,000,000 in the exports of refined mineral oils and $1,000,000 in steel rails.

The following table shows the values of exports of some of the leading articles of domestic manufacture during the twelve months ending December 31, 1903, as compared with the same period in 1902:

Articles—	1902.	1903.
Agricultural implements	$17,981,597	$22,951,805
Books, maps, etc.	4,407,028	4,336,732
Cycles and parts	2,581,255	2,099,092
Automobiles and parts	1,069,782	1,643,029
Cars, carriages, etc.	7,500,064	8,506,092
Clocks and watches	2,121,657	2,216,346
Copper ingots and manufactures	45,485,598	43,509,788
Cotton cloths, colored	8,838,724	6,395,219
Cotton cloths, uncolored	18,030,589	13,337,851
Fibre manufactures	5,111,865	5,642,405
Glass and glassware	2,094,701	2,053,516
Gunpowder and explosives	2,393,480	2,367,148
India rubber manufactures	3,815,754	4,360,965
Electrical and scientific apparatus	6,466,201	8,145,923
Steel rails	1,902,396	937,779
Structural iron and steel	2,828,460	1,788,556
Steel wire	5,140,702	5,528,726
Builders' hardware	11,320,765	12,141,058
Miscellaneous castings	1,685,660	1,765,901
Cash registers	1,220,791	1,825,503
Electrical machinery	5,937,643	5,104,502
Metal working machinery	2,863,709	3,316,088
Pumps and pumping machinery	2,516,300	2,729,288
Sewing machines and parts	4,606,794	5,340,474
Locomotive engines	3,966,007	3,099,521
Boilers and parts of engines	2,432,098	2,273,834
Typewriters and parts	3,575,909	4,537,396
Miscellaneous machinery	20,930,519	20,068,810
Iron pipes and fittings	5,107,183	5,919,340
Miscellaneous manufactures of iron and steel	10,052,766	9,073,059
Sole leather	6,720,966	6,320,665
Upper and other leather, except sole	16,099,430	17,376,746
Boots and shoes	6,470,412	7,244,726
Muscial instruments and parts	3,437,337	3,354,108
Naval stores	13,299,861	14,299,296
Refined mineral oils	62,266,132	65,846,389
Vegetable oils	16,203,002	13,160,379
Paints, pigments and colors	2,219,438	2,566,936
Paper and manufactures	7,251,517	7,339,914
Paraffine and wax	8,398,450	9,596,308
Soap	2,028,264	2,627,633

Articles—	1902.	1903.
Tobacco manufactures	5,523,234	5,204,407
Wood manufactures	12,437,864	13,634,065
Woolen manufactures	1,588,058	2,002,913

The showing for electrical apparatus and machinery, etc., will be noted in particular. Taken together the two items show a total of $13,250,425, as compared with $12,403,844 in 1902. Part of the apparatus is scientific other than electrical, but the general showing is splendid. The slight falling off in electrical machinery value is attributed to the lower range of prices prevalent, but not to any decline in bulk. There is great encouragement in these statistics for electrical manufacturers in pushing for foreign markets. Many of the other items on the list include or conceal material of an electrical nature or purpose.

Vapor Tube Telephone Repeater.

In a patent issued January 19 Mr. Peter Cooper Hewitt describes an important application of the vapor tube for reproducing variations of current in an electric circuit, the latter being either wholly independent or a branch of a divided circuit. The striking feature of the principle is that it enables the production in the secondary circuit of electrical variations of greater magnitude than the original electrical variations in the primary or transmitting circuit. In other words, it offers a solution to the problem of the telephone repeater. As illustrated and described, a magnet in the telephone transmitting circuit is in close proximity with a vapor tube, and the telephone receiving device is in series in the vapor tube circuit. In one form shown the core of the magnet in the transmitting circuit embraces the vapor tube. It is stated that the amplification of the electrical variations in the secondary circuit is due to the fact that a given magnetic variation may cause a wider fluctuation of effective resistance in the gas or vapor than the fluctuations of electrical energy producing the variation of the magnetic field of force. Accordingly, by employing the vapor tube the vibrations of the circuit are magnified, not by induction effects, but by varying the ohmic resistance of the circuit in which the apparatus is placed.

CURRENT NEWS AND NOTES.

ATLANTA BRANCH A. I. E. E.—Plans are being made for the organization in Atlanta, Ga., of a branch of the American Institute of Electrical Engineers.

ELEVEN CENTS PER K. W.—Eleven cents per kilowatt will be the maximum price which is to be charged by the Cincinnati Gas & Electric Company during the next ten years. This scale has been fixed by the city council.

TRANSMUTING METALS.—In a speech on radium at the Hotel Cecil, London, on January 23, Prof. Sir William Ramsay hinted that his recent discovery would possibly open up the question of the transmutation of one element into another. He did not mean to say that silver and copper were transmutable into gold, but it might very well be asked what would happen if gold were made very much cheaper.

ELECTRICAL POSTAGE STAMPS.—King Victor Emmanuel is of opinion that the Italian stamps are not sufficiently artistic, and has, therefore, decided to issue a completely new set of stamps. The new stamps are said to be remarkably artistic and there is a different design for each value. Two of the most interesting stamps are those of one and two centimes, for the first bears the head of Volta and the second that of the modern electrician, Marconi, the inventor of the wireless telegraph.

KAISER HONORS ELECTRICITY.—A cable dispatch from Berlin of January 29 says: "In recognition of their services to the State, Emperor William has had decorations conferred upon Dr. Schulz, president, and Herr Rathenau, general manager, of the General Electrical Company, of Berlin; Herr Denninghoff, manager of the Society for Experimentation in Rapid Electrical Transit, and on several engineers who have been connected with the recent experiments."

PARIS SUBWAY LINES.—Another fire, caused by the short circuiting of the electric current of a train on the Metropolitan Railroad, occurred on January 30, near the La Chapelle Station. A panic followed, in which four persons were injured, none of them seriously. Boring operations in connection with the new Metropolitan line from Courcelles to Menilmontant, which crosses the Place de l'Opera, have been completed, and the work of laying the rails has been begun. The cars will be larger and safer than those now in use, and a tunnel has also been constructed, so as to have a grand station at the Gare Saint Lazare, connecting the Metropolitan with the Western Railway and the Ceinture. The inauguration of the line is expected in July.

IMPORTATION OF CURRENT.—According to advices from Niagara Falls, the question of the exportation of electricity from Canada to the United States has reached a point where it must be decided one way or the other. A deputation, consisting of W. B. Rankine, vice-president, and M. Munro Grier, secretary, of the Canadian Niagara Power Company; J. W. Langmuir, chairman of the Queen Victoria Park Board; G. T. Blackstock and W. Caryl Ely, of the International Railway Company; H. H. McRae, of the Electrical Development Company, and A. W. Maltby, of the Ontario Power Company, have interviewed Premier Ross on the situation. The International Railway Company has made application for permission to bring electric power from its power house on the Canadian side of the river to this side and use it to operate its cars.

RADIUM AND CANCER.—A cable dispatch from St. Petersburg, of January 27th, says: "Prof. Prince Tarkhanov, a well-known scientist, lecturing recently before the Military Association, made some interesting statements in regard to the possibilities of radium. He presented to his audience two cancer patients who had been cured of malignant growths on the face by the use of radium, and expressed the opinion that the problem of determining the sex of children, which Professor Schenck had failed to solve, will soon be settled by the aid of radium. The prince added that he had prevented the development of hydrophobia in dogs inoculated with the virus of rabies, by using radium. When large quantities of radium were available, the prince contended, the whole system of modern warfare would be revolutionized, as powder magazines, whether in forts or in the holds of vessels, would be at the mercy of radium rays, which could explode them at long distances."

MORE THIRD RAIL ROADS.—There appears to be a good deal of activity in various parts of the country in developing third rail enterprises. A corporation to be known as the Minnesota Central Railway Company is being organized by John J. Allen, J. Quist, and others of Minneapolis; F. B. Rossom, of Virginia, prominent in iron land matters on the Mezaba, and some Eastern capitalists. The plans of the company are to build an air line from the twin cities to Duluth and operate it by electricity. It is to be a standard gauge road, and will be 135 miles long, seventeen miles shorter than the Northern Securities roads, the Great Northern or Northern Pacific lines, between the points named, and will be a rival of them for business. Last week also announcement was made that arrangements have been concluded for the building of a third rail street car system between Elmira, N. Y., and Corning. The necessary application will be made to the State Railroad Commissioners at once. A private right of way has been secured and only one grade crossing will be made.

ELECTRIC POWER FOR FACTORIES.—One of the most important lines of work undertaken lately by the National Electric Light Association deals with the sale of current for power purposes by central stations. Of late years the day circuit and the motor load have become vital features of progressive development in the industry and now, on every hand, there is inquiry for fuller information on all branches of the subject. Having this in mind, President Edgar has appointed, on behalf of the association, a committee to obtain and present data in regard to "Purchased Electric Power in Factories," and W. H. Atkins, chairman of the committee, is issuing a circular of inquiry which is well calculated to elicit a large amount of valuable data. Mr. Atkins can be addressed at 3 Head Place, Boston. The other members of his committee are Messrs. S. M. Bushnell and G. W. Brine. It is hoped and believed that responses will be copious and numerous, so that the report will give a further stimulus to the sale of current for power as well as extend the application of motors on central-station circuits. The useful work that the Association thus attempts and carries out so well is highly beneficial to the art, and should have a reflex action in increasing its influence and membership.

THE INVENTION OF THE TELEPHONE.—The newspaper press has once again returned to the subject of priority of invention of the telephone. The story is that in 1901 Judge Kohlsaat, of the United States Circuit Court at Chicago, appointed a special examiner to take evidence in the suit for $50,000,000 damages brought by the Atlantic & Western Telephone Company against the American Bell Telephone Company, American Telephone & Telegraph Company, Chicago Telephone Company, and the Central Union Telephone Company for alleged infringements on Henry C. Strong's inventions. A few days ago the examiner, it is stated, filed testimony tending to deprive Prof. Bell of the credit of inventing the telephone and bestowing the honor upon Strong. According to a dispatch from Chicago, the basis for the suit is an invention to facilitate long-distance telephoning, for which Strong secured a patent in 1885. Strong is nearly 80 years of age and a resident of Chicago.

LETTERS TO THE EDITORS.

Theories in Wireless Telegraphy.

To the Editors of Electrical World and Engineer:

SIRS:—The letter and extracts from M. Blondel's paper published in your issue of January 2nd last afford interesting reading in view of the statements which have sometimes been made imputing priority of publication of the sliding wave theory to M. Blondel. If refutation of Mr. Fessenden's statement ascribing such priority in any degree to M. Blondel were needed, a more admirable answer could not have been forthcoming. M. Blondel's theory, as I have always been fully aware, is *not* mine. It differs in the vital point that his theory involves space-propagated radiation whereas my theory is essentially a theory of surface-propagated or sliding waves. The one does not to any extent account for the great range over which signals can be detected, whilst the other supplies an obvious and simple reason for the effects observed. At the time that I originally framed my theory I need hardly say I was quite unaware of M. Blondel's work, but the theory which he advances was at once so obvious that it was given full consideration and dismissed as not affording a rational explanation of the various phenomena observed. I have therefore no intention whatever to lay claim to a theory to which M. Blondel is so very welcome.

Before baldly referring to my "erroneous ideas" it would savor of better judgment on M. Blondel's part if he took the trouble to prove the existence of the errors he so groundlessly imputes to me, as statements of this kind cannot but be resented unless substantially backed up, whether made by M. Blondel or Mr. Fessenden. I contend most emphatically that it is they who are in error.

In the first place, M. Blondel's theory, despite his statements to the contrary, does not fit in with the facts elucidated by experiments. It is plain from the diagram given of the wave distribution that at quite moderate distances from the transmitter the intensity of the effects produced on a vertical antenna will not materially diminish at very considerable heights above the surface of the ground on this theory. So long as the plan of polarization is sensibly vertical the action on a vertical antenna dependent from a balloon will remain constant whatever be the height. I am not aware that this is in accord with experiment. In the second place the theory involves a denial of the fact that Hertzian waves can be guided by conductors, for, if waves on wires expand as M. Blondel would have them, there is nothing whatever to distinguish them from the ordinary free or space-propagated Hertzian waves which spread through space somewhat in the manner indicated in the theory.

It is certain, therefore, that waves on wires such as were investigated by Hertz himself and by Von Bezold before him have not any such form. Inasmuch as wires prevent the dissipation into space of waves which they conduct it is abundantly clear that two distinct classes of waves are concerned, and this was fully recognized by Hertz as indicated in the diagrams given on page 156 of the English translation of his papers, 1893 edition. If, then, waves on wires differ in form from space-propagated waves there is surely every reason, apart from experimental evidence, for the assumption that wireless telegraphy waves where the surface of the earth replaces the conducting wire are rather of the type of waves on wires than of space-propagated waves.

I fully appreciate the considerations which lead M. Blondel to his view of the case and to the idea that the waves must expand vertically as well as laterally. To some small extent this must be the case, especially when the wave train is a very short and rapidly-damped one, but the effect will generally be quite negligible. Consider the case of an electric shadow thrown by a large conducting obstacle in the path of the waves. The existence of the shadow proves that the expansion of the waves into the region of the shadow after passing the obstacle is not a necessity. Of course, diffraction effects come into play, but if the size of the object be sufficient in relation to the wave length these effects become negligible. Here there is a perfectly analogous case so far as the tops of flanks of the waves are concerned. Indeed, it is a question of the application of Huygens' principle, which is really at the bottom of the matter.

The peculiar way in which M. Blondel makes his lines of force twist and squirm in their frantic endeavors to form a true expanding hemisphere is decidedly quaint and would do them credit if it were true.

I do not for a moment claim infallibility, and I should like to take this opportunity of pointing out a slight inaccuracy which appears in one part of my original publication in the London *Electrical Review,* and which I have for a long time past fully intend to correct. It is, however, just the part which has been accepted as gospel on all hands and which has also been ascribed to Hertz as Hertz's conception of wave formation. I have, however, no desire to palm off my mistakes as those of Hertz. The misconception alluded to is that regarding the ends of the lines of force as gliding along the oscillator or antenna in the formation of self-closed fields of force which are resolved into waves. Strictly speaking there is no lateral motion of the lines of force *at the surface of the oscillator,* at any rate after the oscillations are fully established, a fact which I find Hertz recognized (see page 255 of Hertz's papers quoted above); for if such a motion be assumed it becomes necessary to make the further assumption that the rate of movement is infinitely rapid, thus destroying the value of the conception.

I propose to explain this point more clearly in a further publication shortly, but will here merely point out that although strictly correct as applied to the conception of travelling waves the lateral motion of the lines is not a true explanation of the effects taking place at and near the oscillator itself. In other words it does not properly apply within the quarter-wave-length range about the oscillator or the resonant receiver, either with respect to the electric or the magnetic lines of force. The result arrived at is correct, but the method of deduction is not quite accurate. This may appear foreign to accepted notions on the subject and is rather hard on the electron theory as applied to wireless telegraphy, but I am fully prepared to substantiate the statement.

Another point on which I entirely disagree with M. Blondel. He assumes for obvious reasons that the speed of propagation of wireless waves is not the same as that of light until they have proceeded a large number of wave-lengths from the source. This is in conflict with known laws. The speed of propagation is that of light at distances beyond the first quarter-wave length or thereabouts, provided disturbing factors in the way of reflection, opposing wave-trains, resonance effects, etc., are absent, and that the medium is perfectly homogeneous.

LONDON, ENGLAND. J. E. TAYLOR.

"Cannon Ball Trolley Cars."

To the Editors of Electrical World and Engineer:

SIRS:—Your query, "Why 'cannon-ball'?" at the conclusion of your note entitled "Third Rail in Pennsylvania," and citing that epithet calls forth a reply that may be of interest. The introduction of the high-speed interurban electric line by the Lackawanna & Wyoming Valley Railway Company was an epoch-marking event for this section of the State. Although such a road had been in operation between Hazleton and Wilkesbarre, it does not seem to have elicited as much comment as the L. & W. V. R. R. Prior to its christening that road was known as the "Cannon Ball," presumably on account of the fanciful notion held by this provincial community that the speed of the cars rivalled that of an ordnance projectile. As a result of

a prize contest the road was named the Laurel Line, but in spite of advertising under that name, "the Cannon-Ball road" is still its vernacular title.

The distance from Scranton to Wilkesbarre is 19 miles, and is covered in about 43 minutes by both the Laurel Line and the D. & H. R. R. The former has the advantage of better service and so gets a large part of the traffic. Its rate of fare is 50c. for the round trip. That on the D. & H. R. R. was formerly 85c., but the decrease in traffic due to the inroads made by the Laurel Line caused a reduction of fare to 40c. for the round trip. That did not have the effect of winning back the former business, so it has been apparently decided to fight the newcomer with its own weapon.

In confirmation of the current belief comes the announcement that the Lehigh Valley R. R. (or in other words the Pennsylvania R. R.) will use the tracks of the Laurel Line to provide service in connection with their principal express trains. For years the "P. R. R." has sought entry into this city, and now it has it over a well-built double-tracked road, capable of withstanding heavy traffic and high speeds.

SCRANTON, PA. L. S. LEVY.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Double-Current Generators.—HORSCHITZ.—A mathematical article illustrated by diagrams in which he discusses the copper losses in double-current generators. While a double-current generator is quite similar to a synchronous converter, yet there are two main distinguishing features. The two currents in the converter have opposite directions, while they have the same direction in the double-current generator. In the converter the alternating-current energy is nearly equal to the direct-current energy, while this is not the case in the double-current generator. The author discusses in detail in which way the current in every armature coil is resolved into the direct and alternating currents, which are taken off from the machine. He shows which copper losses and heating are produced by this combination in the whole armature and he compares these losses with the losses which would occur, if the armature would give only direct current. For the double-current generator, when operated on a non-inductive load, he reaches the following conclusions: If generating single-phase current, the losses are very great, as soon as the alternating-current load is 25 per cent. of the maximum possible direct-current load; and the greater the single-phase load becomes the greater become the losses. A double-current generator, giving three-phase and direct-currents, is economical as long as the apparent three-phase power is not beyond 67 per cent. of the maximum possible direct-current power; that is, for instance, as long as an armature which can give 100 kw direct current has not to furnish more than 67 kw, three-phase currents at a power factor equal to unity. The more phases are used the smaller become the copper losses; but there is no use to increase the number of phases beyond six. If the double-current generator is operated on an inductive load, the copper losses become smaller than in the former case.—*Elek. Zeit.*, January 14.

Single-Phase Motor.—An illustrated description of the Schüler-Ferranti single-phase motor, which is a combination of an ordinary

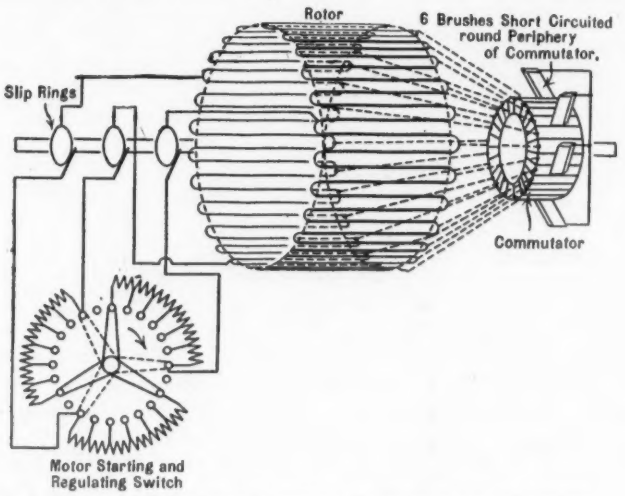


FIG. 1.—DIAGRAM OF CONNECTIONS OF SINGLE-PHASE MOTOR.

single-phase induction motor and a repulsion motor. In some tests in which a single-phase motor with an armature wound as for continuous current, was run as a repulsion motor pure and simple, he found the starting torque to be good, but to decrease rapidly. On the other hand, when the same motor was run as a single-phase induction motor with a three-legged resistance in its rotor circuit, the torque is zero at start, but increases gradually to a maximum. This behavior is exactly opposite to that of the repulsion motor. Schüler combined, therefore, these features of both types of machines in one motor and the outcome is the arrangement shown in Fig. 1. At any speed the motor torque is approximately equal to the sum of the torques due to the repulsion motor and to the induction single-phase motor, respectively. This feature is shown in the curve of Fig. 2. At starting the three-legged resistance is inserted in full in the

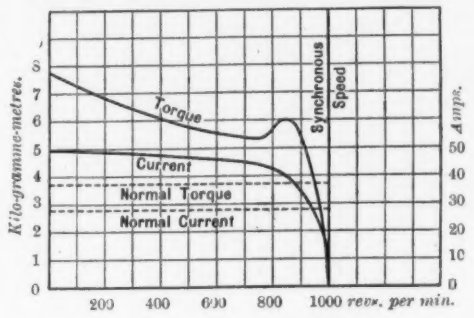


FIG. 2.—CHARACTERISTIC CURVES.

rotor circuit, and the current flows by way of the commutator and the short-circuited brushes. The motor then starts as a repulsion motor. By gradually cutting out the starting resistance, part of the induced armature current flows through the resistances and the motor begins to act as an ordinary single-phase induction motor. By means of the three-legged resistance, the motor speed may be varied in wide limits, the torque varying to a comparatively small extent.—Lond. *Elec.*, January 15.

REFERENCE.

Single-Phase Commutator Motors.—OSNOS.—The conclusion of his long illustrated article in which he discusses the various forms of single-phase commutator motors. After having described the compensated series motor and the compensated shunt motor, he discusses the methods of regulating the speed and torque, of changing the direction of rotation and of avoiding short-circuit currents in the various types of motors discussed by him.—*Elek. Zeit.*, January 14.

LIGHTS AND LIGHTING.

Arc Light for Photochemical Purposes.—An article in which it is said that for photochemical purposes (making blue prints, etc.), the ordinary arc lamp is uneconomical. An arc lamp of a German company is described which is claimed to be specially suitable for such purposes. It is an enclosed arc lamp, the life of the carbons being given as 250 hours. By carefully keeping the air away and using a high-voltage (say, 200 volts direct current) an arc of 25 to 30 mm. is obtained, which is chemically very active. With such a special 200-volt lamp the consumption of current for the same chemical effect is claimed to be less than one-fourth for the ordinary 55-volt lamp.—*Zeit. f. Beleucht.*, December.

Electric Arc Between Carbons.—BLONDEL.—A long article in which

the author summarizes and critically discusses the work of Mrs. Ayrton on the mechanism of the electric arc between carbon electrodes.—*L'Eclairage Elec.*, January 2, 9.

Mercury Arc.—DE VALBREUZE.—A fully illustrated article in which the author gives a summary of the various investigations on the electric arc through mercury vapor.—*L'Eclairage Elec.*, January 16.

POWER.

Blast Furnace Gas as a Source of Power.—An illustrated description of the Thwaite system for using the blast furnace gases, now largely wasted, for driving gas engines and generating electric power. In an editorial on this subject it is pointed out that about 50 per cent. of the effluent gases of a blast furnace are available for use for other purposes than those connected with the operation of the furnace itself. For every ton of pig iron produced per hour about 840 hp is available for other uses. Considering the immense production of pig iron at many plants, it appears that these plants are bound to become centers of generation and distribution for large amounts of power in their vicinities.—*Power*, January.

REFERENCES.

Electric Pumps and Compressors.—RICHARD.—In a continuation of his serial on mechanical applications of electricity he gives brief, concise and illustrated descriptions of various electric pumps constructed during recent years, especially for use in mines and metallurgical plants. Among the apparatus described are the pumps of Deane, Knowles, Mavor & Coulson, Merryweather, Hammersmith. There are also described several air compressors for use in connection with compressed air brakes in traction, compressors of Christensen, Batchelder and the Thomson-Houston Company being described.—*L'Eclairage Elec.*, January 2.

French Water Power Plant.—DOMAR.—An illustrated description of the plant of the Electrometallurgical Society of Saint-Beron. It contains five turbine-driven, two-phase generators, giving 3,000 or 6,000 amp. at 80 or 40 volts, respectively. They supply 12 electric furnaces for making calcium carbide.—*L'Eclairage Elec.*, January 16.

Shawinigan Falls.—PERKINS.—An illustrated description of recent equipment for the power house of the Shawinigan Falls Power Company.—*West. Elec.*, January 23.

Superheated Steam.—BUHLE.—An illustrated description of the Pielock system of superheated steam.—*Dingler's Polytech. Jour.*, January 2.

TRACTION.

"Electrothermic" Operation of Railways.—LENGENHAZER.—An illustrated article on a peculiar system which is said to be now under consideration by the general management of the railways of Switzerland. The main idea is to retain the old locomotives, but to produce the heat for heating the water not by burning coal, but by the electric current in resistance, properly arranged, so as to get a very high efficiency for the transformation of electrical energy into heat. For this purpose the resistances consist of extremely thin layers of "noble metals," burned into mica plates, so as to have a very small cross-section and a very large surface. If the boiler has a capacity of 4,000 liters water it is calculated that to heat them from 10° to 190° C., corresponding to a steam pressure of 15 kg. per sq. cm., 300 kw are required. For a steam consumption of 1,000 kg. per hour, about 225 kw would be required. The following advantages are claimed for this system. When a train starts there is no sudden increase in current consumption, so that the load curve is more uniform. Direct or alternating current may be used. The regulation of the heat is very simple, since only resistances are inserted to or switched off from the circuit. The present railway engineers would easily become acquainted with the new system.—*Elek. Anz.*, January 7.

Jackson & Battle Creek Railway.—A description of this new third-rail road, 45½ miles in length, recently put in operation in Michigan and operating cars at a maximum speed of 60 miles per hour. The third rail weighs 70 pounds per yard and is used throughout the line except in the cities, where the overhead construction is employed. Power is purchased from a water power plant located 45 miles from one terminus and 90 miles from the other terminus, and is transmitted at 40,000 volts and 60 cycles. Rotary converters are used in the substations. The railway company pays 1¼ cents per kw-hour for the first 3,000 kw-hours per day, and after that at the rate of one cent per kw-hour.—*St. R'y Jour.*, January 2.

Rail Bonds.—HARRINGTON.—The first part of a fully illustrated Franklin Institute paper on rail bonds. As the vital features he considers: primary, life and conductivity; secondary, cost and design. He describes types of bonds which now represent the best practice in the United States, and starts with a discussion of protected rail bonds.—*Jour. Frank. Inst.*, January.

Sheffield.—SAMPLE.—An illustrated description of the trolley system of Sheffield, England, which comprises 29 miles of double-track and 7 miles of single-track. The nominal capacity of the power plant is 3,675 kw.—*St. R'y Review*, January 20.

Seattle.—A fully illustrated article on the "Stone & Webster properties on the Puget Sound," and especially the Seattle Electric Company, which does the electric railway lighting and power business of Seattle. The company has eight power stations, the equipment of which is described. The traction system is dealt with at length.—*St. R'y Review*, January 20.

Tram Cars.—HERZOG.—The first part of an article on the construction of cars built by Swiss companies for electric tramways. Some detailed drawings are given.—*Zeit. f. Elek. ü. Masch.* (Potsdam), January 16.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Electromechanical Compounding System.—BROCK.—An illustrated description of the electromechanical compounding system of Routin. In the regulation of steam-driven dynamos, the speed must be adjusted by varying the admission of steam to the engine and on the other hand the voltage must be varied by changing the excitation. Both changes should be made simultaneously, but the changes of admission of steam require time, since the mechanical devices are subject to the law of inertia. The condition for the successful regulation is, that with increasing current consumption and with decreasing voltage or decreasing speed, the admission of steam should be increased and the excitation simultaneously increased, while with decreasing current consumption and increasing voltage or speed, both the admission of steam and the excitation should be diminished. The device of Routin, as shown in Fig. 3, consists of an iron

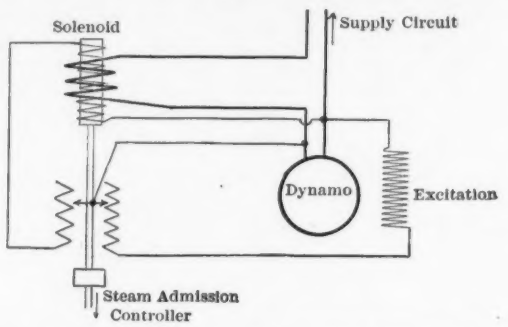


FIG. 3.—ELECTROMECHANICAL COMPOUNDING SYSTEM.

core, on which is acting the difference of the ampere windings of a main current coil and of a voltage coil. Through the main coil flows the current given out in any moment from the machine, while the shunt coil (which is connected in opposition to the main coil), is connected across the terminals of the generator is in series with a resistance which may be regulated by the sliding contact, *a*. Simultaneously with the sliding contact, *a*, the sliding contact, *b*, moves which, by its changed position on the resistance, *R*, influences the excitation of the machine. The dimensions of the coils are so chosen that the action of the shunt coil is always superior to that of the main current coil. The iron core of the solenoid is coupled to the devices which determine the steam admission to the engine, and carries a weight, *P*, which gives an attractive effort downwards. When the iron core sinks downwards the steam admission is increased, and if it rises upwards the steam admission is diminished. The motion of the iron core is the result of the differential action of the two ampere windings.—*Elek. Zeit.*, January 14.

French Gas-Driven Power Plant.—A note on what is considered to be one of the largest gas-driven power plants in France. It is the plant in Valenciennes which was formerly operated by steam, but has been converted to a gas-driven one in consequence of a dispute arising with the local gas company with regard to certain concessions held by the company. A settlement was arrived at, the electric company agreeing to a minimum purchase of 50,000 cu. m. of gas per

year at a price of 2 cents per cu. m. Four 110-hp gas engines have been erected in the engine room and they are remarkable for the fact that one of the two cylinders, which are mounted in tandem, is double-acting, the other being single-acting. They drive four direct-current dynamos, each giving about 400 amp. at a voltage of from 225 to 250. A smaller set of about 40-hp capacity is used in connection with the buffer battery and for light loads. The three-wire system of distribution is used and electricity is sold for lighting at a price from 11 to 15 cents per kw-hour, and for power purposes at a price of 7 to 10 cents.—Lond. *Elec.*, January 15.

Electric Installation on Board Ship.—A very long and profusely illustrated description of the Chilian battleship *Libertad*. The following information is given concerning the electric equipment. The use of incandescent lamps throughout the vessel is most complete. The total number of lamps is about 1,000—generally of 16 cp—with 50-cp lamps in clusters on the yard arms, and lamps of 50 cp for the coal bunkers. There are five dynamos in the vessel, each of 500 amp. at 100 volts, when running at 400 revolutions, together with the necessary engines, these dynamos being all coupled up to the switchboard by specially insulated cables. The switchboard is suitable for parallel running, is capable of dealing with the total number of dynamos and circuits required, and fitted in a position adjacent to the dynamos, easily accessible and convenient as regards manipulation of switches and other necessary work at the switchboard. The circuits are distributed by means of specially insulated cables to gun metal section boxes, which boxes feed the water-tight distributing or cut-out boxes, from which the lamps are controlled. In addition to the above, there is a rotary transformer, the whole being arranged so that the complete electrical equipment is entirely under the manipulation of one engineer. Five powerful searchlights of a special pattern are fitted, and generally arranged so that they can be withdrawn into cover during action or stress of weather. All the projectors are provided with automatic feed lamps and mirrors on the Mangin principle. In addition to the electric lighting plant there are about 70 electric motors in the vessel, generally for ventilating purposes; electric ammunition hoists are also arranged for the 7½-in. guns, and, wherever suitable, electrical power has been applied so as to reduce, as far as possible, manual labor on board.—Lond. *Eng'ing*, January 15.

Electric Installations on Board Ships.—LEBLOND.—The first part of what appears to become a long serial discussing in detail the design of electric installations on board ship and emphasizing those points in which such installations differ from installations on land. For instance, while on land always one central station would be used to distribute electricity over a comparatively small area, there are often two separate plants on board ship. Direct current is always used and while formerly the voltage was 70 or 80 it is now the intention in France to use in future 120 volts.—*L'Ind. Elec.*, January 10.

ELECTRO-PHYSICS AND MAGNETISM.

REFERENCES.

Electric Oscillations.—WAGNER.—An article in which the author endeavors to give in concise form the foundation of the theory of physical phenomena in the transmitting and receiving apparatus for wireless telegraphy. He gives the fundamental differential equations and their general solution for waves along a straight wire and in a closed oscillation circuit.—*Dingler's Polytech. Jour.*, January 16.

Radioactivity.—CURIE.—A long summary of recent researches on radioactivity. The subject is dealt with under the following headings: Radioactive substances; the different rays given off; heat developed by the salt of radium; induced radioactivity and radioactive emanations.—*Jour. de Chimie Phys.*, December.

ELECTRO-PHYSICS AND MAGNETISM.

Electrolytic Stripping of Metals.—BURGESS.—An illustrated article on the method of removing brass from iron. A number of years ago, when the manufacture of bicycles was in its most prosperous stage, an important department in each factory was that devoted to filing, where the thin layer of brass on the surface of the frames was removed by a corps of workmen stationed at benches around the room. Later, however, the filing room was changed to an electrolytic stripping room, since the latter method was found to be much more economical and convenient. The method itself is described in detail and the tanks and special fittings for the treatment of the bicycles are illustrated. The gist of the method is that the brass-covered iron is placed as anode in a sodium nitrate solution; when the current passes from it toward an iron cathode, the zinc and copper are completely removed, while the iron which is in its passive state is left smooth and bright. The current density is between 5 and 15 amp. per sq. ft., while the pressure required is 3 to 5 volts. Silver, copper, tin, zinc, lead, cadmium and the various alloys can be removed from iron in this way and this points out various other applications of the process. It offers a convenient and rapid method for removing silver from plated articles of iron, which are to be resilvered and also for removing silver from suspension rods, hooks and baskets used in silver plating, thus not only recovering the suspension devices themselves, but the silver as well. Files which have been used upon brass, copper, lead or other soft metal and have become clogged may be quickly and effectively cleaned by suspending them as anode in a sodium nitrate solution. A layer of tin on tinned iron may be removed completely in a few minutes in the same manner without dissolving any of the iron.—*Electrochem. Ind.*, January.

Manufacture of Steel in the Electric Furnace.—BENNIE.—A fully illustrated article on the process of Gin for the electric manufacture of steel in a resistance furnace of special design. The furnace used is in form of a channel of great length and small cross-section, filled with fused cast iron and having at its terminals blocks of steel cooled by an internal current of water. The passage of the proper amount of current in the conductor of fused metal sets free a sufficient quantity of heat to maintain the whole mass in fusion, and to bring it to the most favorable temperature for producing the refining reactions. The large section of the blocks forming the terminals of the circuit prevents a great rise of temperature in them, being aided in this respect by the circulation of cold water. To give a convenient form to the hearth, the channel in which the metal is held is doubled on itself several times, so that there is formed a sort of huge incandescent lamp, of which the filament consists of a stream of molten iron. In practice the furnace is carried on a movable carriage on wheels in an arched furnace, the fused pig iron being introduced from the latter into the electric furnace. There are two essentially different methods of operation, the one being the "dilution method" (scrap process) in which the calculated proportion of scrap iron is added to the fused bath in which it dissolves. The carbon diffuses with great rapidity throughout the mass and the conversion of the whole into steel takes but very little more time than that needed for the fusion of the added metal. The other method is to add some iron oxide (ore process); the oxygen of the iron oxide added to the bath burns the silicon, manganese and carbon. A mixed method involves the use of a certain amount of scrap and oxidation by the addition of iron oxide. The pig iron is treated with some iron ore and lime, so as to oxidize the impurities while producing basic slag, which facilitates the elimination of the phosphorus. When the purification is sufficient the scrap iron is introduced into the very hot bath, the slag is removed when fusion is complete, and the final additions of ferromanganese are made, to reduce the oxide dissolved in the metal. The use of this mixed process depends upon the nature of the possible supply of raw materials. The process is thought to be well adapted for the manufacture of special steels. An example of the application of the process of oxidation is discussed at length and some data are given on the cost of the process. —*Electrochem. Ind.*, January. An illustrated article by Gin on this same process is given in *L'Eclairage Elec.*, January 9.

REFERENCES.

Action of Sodium and Potassium Amalgams on Various Aqueous Solutions.—FERNEKES.—A long account of an experimental investigation on this subject in which he reaches the conclusion that the electrolytic dissociation theory is unable to explain the facts. He gives an explanation based on Kahlenberg's hypothesis that a theory of solutions is to be based on chemical affinity, the affinity between solvent and dissolved substance, and the formation of a true chemical compound whose properties are different from either constituent. The author believes that an explanation of the various catalytic actions can be given on the basis of this theory.—*Jour. Phys. Chem.*, December.

Electrotypes.—COWPER-COLES.—An illustrated description of various methods, mainly taken from patent specifications or trade publications, for rapidly producing electrotypes. Some kind of agitation is necessary and the following four methods are distinguished: The electrolyte is circulated and at the same time agitated; the electrolye is circulated only; it is agitated only; the electrodes are moved;

the electrolyte is circulated and filtered.—*Electrochem. & Met.*, December.

Units, Measurements and Instruments.

Double-Tariff Meter.—A note on an instrument of an English company for registering electrical energy supplied at a double rate of charging, according to the hours of the day during which energy is consumed. It consists of two watt-hour meters of any make and a contractor clock. On the arbor, to which the hands are attached, are mounted two cams, these actuating two contact springs. By setting the cams suitably, the shunt circuits of the two watt-hour meters are opened and closed by the contact springs at the pre-determined times. The clock is made to run for one month with one winding. One of the meters referred to registers the total number of units consumed, while the other marks the number of units sold during any particular period. All the contacts of the contactor are on the front of the clock, and periodical inspection may be made without disturbing the seals. These double-tariff meters may be used either for continuous or for alternating current.—Lond. *Elec.*, January 15.

REFERENCE.

Selenium Cells.—An illustrated description of various forms of selenium cells and apparatus made by Ruhmer. A practical application of the same is the use of a selenium cell in combination with a relay for automatically lighting and turning off gas and electric light, when it gets dark or with the coming of dawn. Whether such an apparatus is used in real practice is not stated.—*Elek. Anz.*, December 17.

Telegraphy, Telephony and Signals.

The Antenna in Wireless Telegraphy.—Chant.—A fully-illustrated account of an experimental investigation on the variation of potential along the transmitting antenna in wireless telegraphy. In the simple Marconi method and the method of direct excitation, when the antenna is joined to earth, the effect is similar to using a wire the same as the antenna to balance it; that is, considered from an optical point of view, the earth acts as a plane mirror. In these conditions the chief oscillation is the fundamental of the antenna, with a wave length four times its length. The condenser circuit in the method of direct excitation impresses its wave length on the antenna, but its oscillations are not nearly so intense as those proper to the antenna itself. Thus the manner of oscillation is essentially the same in the two methods, but the latter is more regular and powerful than the former. In the inductive method of excitation, on the other hand, the prominent feature of the oscillations is that one due to the condenser circuit. With antennas of different lengths, there is little change in this oscillation, the curve indicating it being decided and definite; but only one-quarter of its wave length is shown. This may be due to the great losses from radiation by the wire. The fundamental proper to the antenna is also present, but it is not nearly so intense as in either of the other two systems. The most effective length of the antenna, therefore, is one-quarter wave length, not a higher multiple. When inductance is inserted between the condenser circuit and the earth, the fundamental oscillation is not so regular or intense, other oscillations (overtones) being superposed. For the production of oscillations by the direct method a small capacity cannot satisfactorily balance the antenna; in the inductive method, however, a capacity acts like an earth connection or a similar wire.—*Am. Jour. Science*, January.

Measuring the Wave Length in Wireless Telegraphy.—Drude.—A communication in which he describes the following method of measuring the wave length which he has found to be quite exact, while the apparatus used is so simple that any one can make it himself. The principle is to adjust the secondary circuit so as to be in resonance with the primary circuit to be tested. The secondary circuit consists of a circular plate condenser (with air, petroleum or water as dielectrics, while glass is better avoided since its dielectric constant depends on the frequency), and the self-induction in the form of an exactly rectangular coil. The length of the rectangle may be varied by means of a sliding contact piece, the position of which is changed by hand. The position of this sliding contact is read off on a scale which is calibrated in wave lengths. As wave indicator he uses in the laboratory or in open air at night a vacuum tube containing sodium or during day time a small air-gap over the condenser plates.—*Elek. Zeit.*, January 7.

Miscellaneous.

REFERENCES.

Manufacturing Plant.—A fully-illustrated description of the new workshops of the Société Alsacienne de Constructions Mecaniques in Belford for the manufacture of large dynamos. The power used is taken from a 200-kw central station. The intention is to drive each tool directly by an electric motor, and it has been decided to do so with any new tool which consumes not less than 1 to 1.5 kw, while the older tools have not been changed. Some special machine tools are described.—*L'Ind. Elec.*, December 25.

Metric System.—A note stating that the Parliament of New Zealand has authorized the Governor to adopt, beginning with January 1, 1906, the metric system of weights and measures, so that from this date this system will be the only one officially recognized in New Zealand.—*L'Ind. Elec.*, December 25.

Electrical Law.—Ball.—A comparison of the law of electric lighting in England and America. The subject is dealt with under the following heads: Interference with property and vested interests; responsibility for accidents; responsibility for nuisance; damage caused by escaping current; transmission of messages by electricity; relations between companies and local authorities.—*Traction and Transmission*, January.

Fuel Handling Machinery.—Dawson.—The first part of a profusely illustrated serial on this subject. Various American firms are mentioned as originators of special types of coal and ash handling machinery.—*Taction and Transmission*, January.

New Books.

The Gas Engine. By Frederick Remsen Hutton, E.M., Ph.D. New York: John Wiley & Sons. 483 pages, 243 illustrations. Price, $5.00.

This book is intended as a complement to the author's previous work on the "Mechanical Engineering of Power Plants," and thus to complete the discussion of the general subject of engineering as related to the liberation of heat energy by processes of combustion, and its transformation into mechanical form by some type of mechanism constituting a heat engine. The point of departure in the present work is the liberation of heat energy by some process of combustion involving an explosive gaseous mixture. Then follows a discussion of the cycle of operations which the heat medium undergoes in transforming the heat energy into mechanical work, taken in connection with the types of motor in which these transformations are effected. The succeeding chapters then open up the details of mechanically effecting the mixture of fuel and air, its ignition, and the control of fuel supply in correspondence with the external work. Following these matters of practical arrangement, an extended theoretical discussion is given of the various possible cycles of operation. The treatment of this topic is clear and full in scope and gives perhaps the most satisfactory and complete general exposition of the subject at present in print. Credit for this chapter is given by the author to Dr. Charles E. Gucke, who developed the subject matter as a student under the author's direction.

Some reference is also made to internal combustion engines with heating at constant pressure, and to the possibilities of developing practical types, either of the reciprocating or turbine variety. The book closes with an account of various experiments on explosive mixtures, with a historical summary of the development of practice in this field of engineering, and with a bibliography of most of the important literature of the subject. No attempt is made to enter upon the field of design of the gas engine as a machine. The author considers that this field has been already sufficiently covered, and that the space at his disposal might be better used by a discussion of the engine with reference rather to its thermal and general relations, as indicated above.

The preparation of the book as a whole displays industry in gathering together the materials from varied sources, together with skill and judgment in combining them so as to form a satisfactory and fairly adequate presentation of the subject. The book should go far toward answering a distinct want in our present engineering literature on this subject, and it will be an acceptable addition to the library of all those who are specially concerned with the latest phases of power plant engineering practice.

Crompton Potentiometer.

The Crompton form of potentiometer, shown in the accompanying illustration, has been largely adopted in English lighting and power stations as a standard for verifying apparatus of all kinds, and for measuring the output of the machines and stations. It also forms part of the equipment of many technical schools and laboratories.

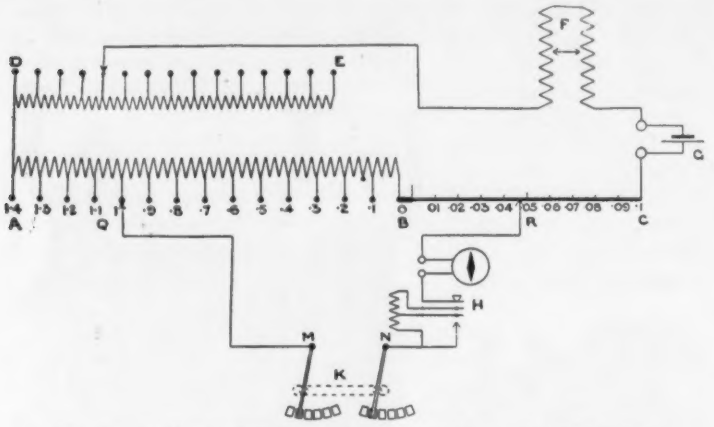


FIG. 1.—DIAGRAM SHOWING CONSTRUCTION OF INSTRUMENT.

The construction of the instrument is diagrammatically represented in Fig. 1.

The calibrated wire is arranged in 14 coils, called potentiometer coils, lettered *A B*, and a straight section, *B C*, called the scale wire, the resistances of the several coils and of the straight section being equal. One sliding contact, *Q*, moves over the terminals of the 14 coils, and another, *R*, along the straight wire. The reading of the instrument in the position shown is 1.046. The pairs of points whose potential differences are to be compared are connected to the blocks of the double pole switch, *K*, whose levers, *M N*, connect them, one pair at a time, to the sliding contacts, *Q R*, through the galvanometer. The galvanometer key, *H*, is arranged to complete the circuit through two resistances, which are short-circuited in succession as the key is depressed. The current required is derived from a small secondary battery, *G*. An adjustable resistance, consisting of a set of coils, *D E*, and a continuous rheostat, *F*, is placed in the circuit. By adjusting these the resistance of the circuit and the current passing through it from the storage cell, and consequently the fall of potential along the scale wire, can be continuously altered, and the operator is able to obtain a galvanometer balance against a standard cell when the reading of the sliders is that of the known e.m.f. of the cell at its actual temperature. If, for example, the temperature of the cell be 15°, so that its e.m.f. is 1.434 volt, the sliders may be set to that reading, and the galvanometer brought to zero by adjusting the resistance, *D E*, and the rheostat, *F*. When this has been done the scale readings at all points are direct readings in volts.

A view of the potentiometer is given in Fig. 2 and a diagram of its internal connections in Fig. 3. Here *a b* is the scale wire; *c* the set of equal potentiometer coils in series with it; *d* is the double pole switch connecting the 6 pairs of terminals, *A B C D E F*, in succession to the slide contacts; *e f* are the resistance coils and rheostat respectively, and *G* is the galvanometer key. All the moving contacts are under glass, and the coils and the scale wire are inside the box. The box itself is completely closed, but the inside can be inspected by removing a sliding bottom. Nearly all the measurements made involve the use of a standard cell, and one pair of terminals, the pair, *A*, is assigned to its connections to save confusion in working. Fuses of fine wire are inserted at all terminals except those for the galvanometer to save the instrument coils in the case of an accidental connection to a source of high pressure.

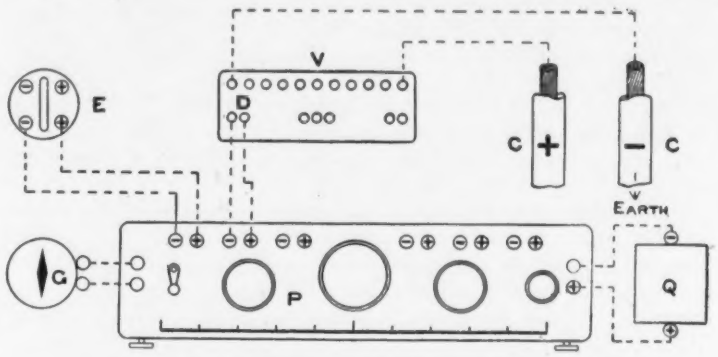


FIG. 4.—CONNECTIONS FOR TEST OF SUPPLY MAINS.

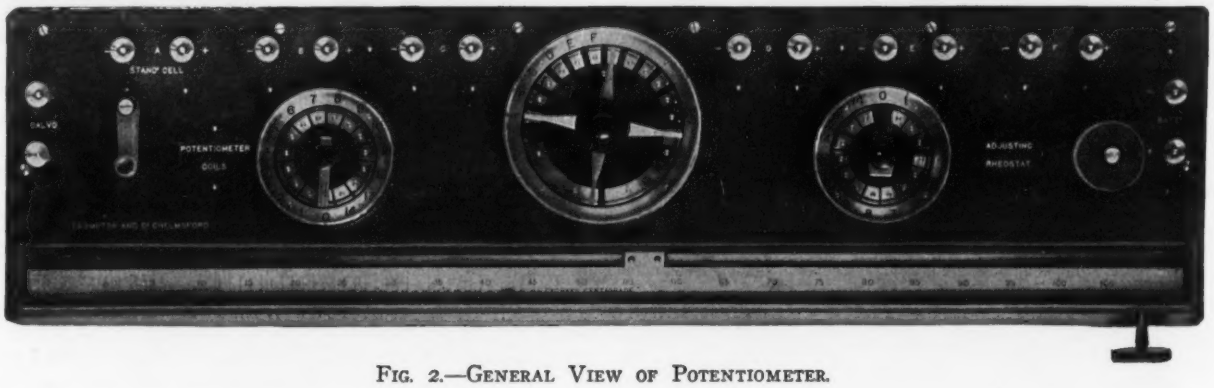


FIG. 2.—GENERAL VIEW OF POTENTIOMETER.

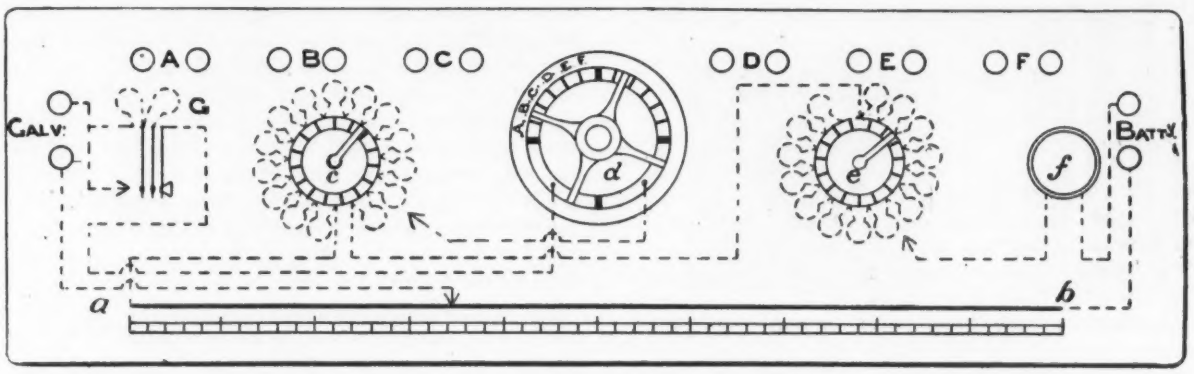


FIG. 3.—CONNECTIONS OF POTENTIOMETER.

Two scales are engraved for slide wire readings. One is a series of even divisions from 0 to 105, the resistance of the scale wire between 0 and 100 being the same as that of each potentiometer coil. It has been found convenient to be able to take readings a little beyond the 100 mark without having to move the potentiometer coil switch, and the scale is extended to 105 to admit of this. The other

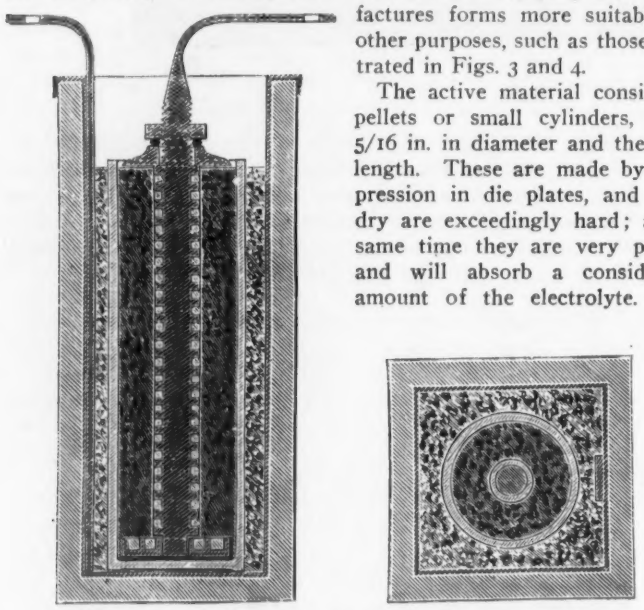
scale gives the values of the Clark cell at different temperatures, and is used in the following way: The potentiometer coil switch is set to 14, and the slide to the temperature of the Clark cell taken from the thermometer attached to it. The potentiometer reading is then the correct value in volts of the Clark cell at that temperature. By adjustment of the rheostat the galvanometer is balanced, and when this has been done the current in the potentiometer wire is such that readings at all points give correct values in volts, and the instrument is a direct-reading voltmeter. Its maximum range is then 1.5 volt, reading in thousandths of a volt, and by inspection to ten thousandths.

Volt boxes are employed consisting of sectional resistances. For example, a box designed to carry up to 1,500 volts consists of ten resistances in series, each of 10,000 ohms connections. Connections to various points of this resistance are made to terminals. Thus, between the terminals connected across 100 ohms, if the voltage applied is 1,500, the voltage across these terminals will be 1.5, a convenient quantity for comparison with the Clark cell.

The accompanying diagram illustrates the application of the potentiometer to the measurement of the voltage of electric light mains. The volt box, *V*, is connected across the supply mains, *C* and *C*, and the one pair, *D*, of potential terminals is connected to the potentiometer, that pair being chosen which is nearest to zero potential. The difference of potential between the terminals, *D*, is compared with the e.m.f. of the Clark cell, *E*, and the voltage of the mains supply calculated from it.

A New English Storage Battery.

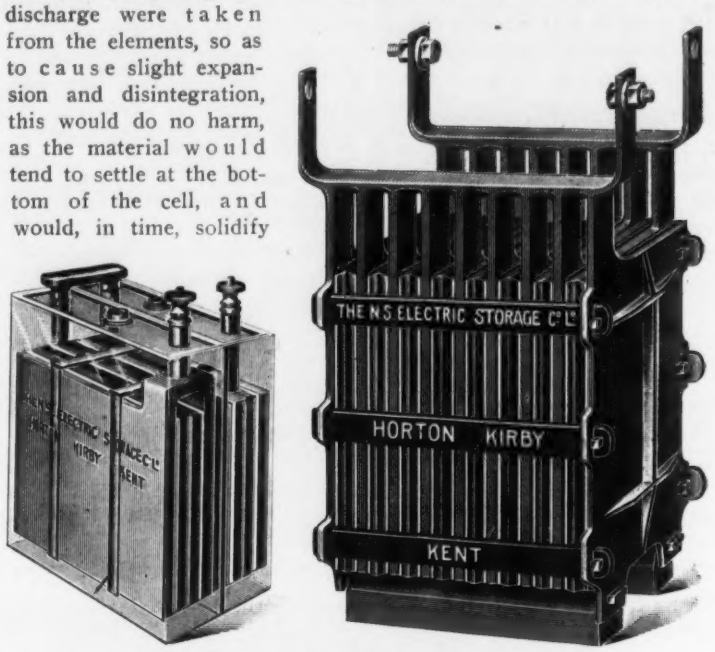
The illustrations herewith show a new type of storage battery, known as the N. S. storage, and being introduced by the N. S. Electric Storage Battery Company, Limited, 139 Queen Victoria Street, London, England. The inventor is Mr. J. T. Niblett, well known as the author of a treatise on storage batteries. While certain of the principles in the battery are not entirely new, yet there are a number of novelties in it and Mr. Niblett has arranged his active material in a way different from anything that has been previously done. The cell is of the porous pot type, a section of which is represented in Figs. 1 and 2, one showing a vertical section and the other showing a horizontal section. While this is the leading type manufactured, for the purpose of suiting other demands, the company also manufactures forms more suitable for other purposes, such as those illustrated in Figs. 3 and 4.



FIGS. 1 AND 2.—VERTICAL AND HORIZONTAL SECTIONS OF CELL.

The active material consists of pellets or small cylinders, about 5/16 in. in diameter and the same length. These are made by compression in die plates, and when dry are exceedingly hard; at the same time they are very porous, and will absorb a considerable amount of the electrolyte. The pellets are packed in a porous pot round the positive electrode, of the form shown in the figure, while the space between the pot and the lead containing box (the negative electrode) is packed with disintegrated lead. A wooden case surrounds the whole. One of the advantages claimed for these cells is that, should the electrolyte escape by any means, it would not stop the discharge, as such a large quantity of solution is absorbed in the pores of the active material and the separator, that it allows action to go on for some considerable time. Cells have been emptied and then discharged at the normal rate, and have given half their normal capacity under these conditions.

Three distinct types of cell are made. The solid, which is more suitable for large electric lighting installations, central stations and tramway work, is considered the best, as in its present form it can be supplied at low rates, and it has the advantage that short-circuiting has practically no injurious effect. Owing to the large amount of exposed active material on both the positive and negative sides, very high rates of charge and discharge may be taken from the cell without in any way injuring it. It is stated that even if excessive rates of discharge were taken from the elements, so as to cause slight expansion and disintegration, this would do no harm, as the material would tend to settle at the bottom of the cell, and would, in time, solidify and become active, so that no loss in capacity of the cell would occur.



FIGS. 3 AND 4.—TWO FORMS OF N. S. STORAGE CELL.

The second type is termed the semi-solid accumulator. This is built up of special grids, which are thick, and contain a large amount of active material. This material is of the same composition as that used in the solid cells, and, being highly porous, may be used in thick masses. In this case ribbed porous plates are employed for the separators, and the elements are held together by stout clamping plates, which really constitute the outside negatives of the sets of elements. These clamping plates are pressed together by connecting bars having a flange at one end and an india rubber pad pressing against this, so as to allow for expansion and contraction during the charging and discharging operations. These cells are used for low-capacity batteries, and in cases where a small and light battery is required, also for motor-car driving.

The third type of cell is termed the portable type. These are supplied made up into batteries ranging from two to six cells for medical purposes, carriage lighting, X-ray work, actuating small electromotors, and for ignition purposes for petrol engines and motor cars. In constructing these cells, which are also of a semi-solid type, the first consideration has been durability, and the elements are of a very robust character, well calculated to withstand the jerking and jarring which they may receive when on vehicles or when being carried about. The elements are mounted in vulcanite or celluloid cases, enclosed in a hard-wood containing box, and are fitted either with two terminals, or with terminals to each cell as required.

The makers state that the cells behave much in the same way as the ordinary form of accumulator. The electrical pressure of the cells immediately after charging is about 2.2 volts, but this quickly sinks to the normal 2 volts. On the discharge the fall of potential is proportional to the rate of discharge, but to discharge down to 1.7 volts for a lighting circuit is quite permissible, and in the case of tramway and power circuits they may be discharged down to as low as 1 volt per cell. This apparently does not injure them in any way.

As much as 95 per cent. quantity efficiency and from 70 to 75 per cent. energy efficiency has been obtained with both the solid and the semi-solid types of cell. The capacity per pound of complete cell, in the case of the solid batteries, is about 4 watt-hours. In the case of the smaller cells it may be somewhat less, but as the capacity of the cell increases, the capacity per pound of complete cell tends to increase, a condition not usually met with. In the case of the semi-

solid cells, about 10 watt-hours per pound of complete cell are obtained, but this, of course, is regulated by the nature of the containing boxes, whether they are of vulcanite, glass or lead-lined wood. With the small portable batteries, capacities have been obtained up to 12 watt-hours per pound of complete cell.

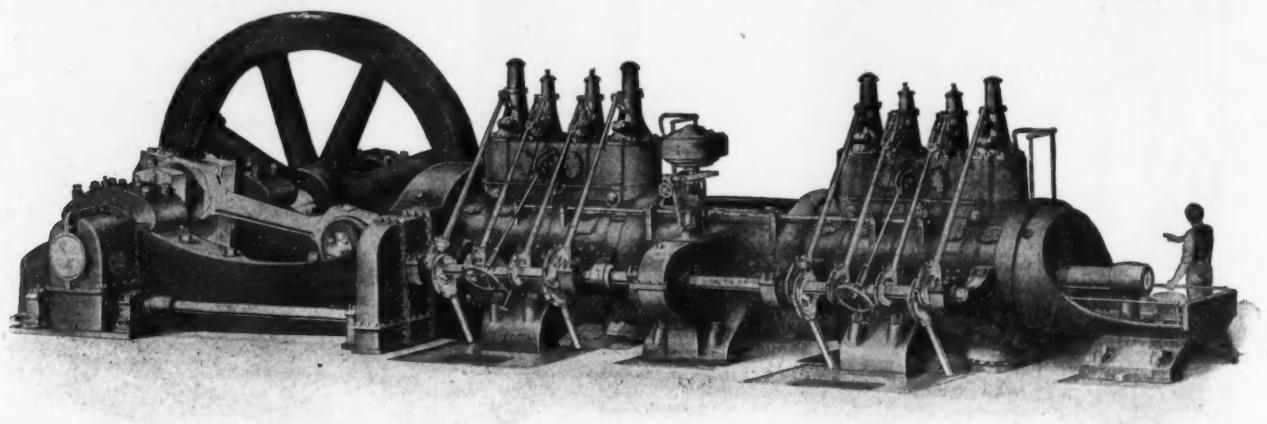
A solid cell made up some 15 months ago was taken out of a battery, discharged, and then emptied, and was allowed to stand idle for a matter of four months. At the expiration of this time the cell was filled up with electrolyte, and put on charge, and after one or two charges and discharges it was found to be in perfect condition.

The cells have been frequently short-circuited, but no detrimental effect seems to occur; they have also been run down until they showed absolutely no pressure whatever, and on the re-charge they appeared to come up quite well. This is believed to be due to the fact that the elements have an enormous amount of exposed surface, and the active material cannot disintegrate or leave the conductor. The simple construction of the "solid" cell, rendering skilled labor superfluous, both in manufacture and in working, is one of its most prominent features.

The Allis-Chalmers Nurnberg Gas Engine.

It is but a few years ago that the engineering fraternity in general looked askance at gas engines of even 150 hp, and the field was generally slighted. It was not until the industrial conditions in Europe rendered it absolutely essential to reduce the cost of power production to a minimum, when, aided by a more thorough comprehension of the action of such engines, the modern large gas engine came into being and was installed and operated with such success in Europe, that it has already been accepted as a staple.

Realizing the vast importance of these developments and in the consistent pursuit of its traditional ambition to remain in the van of American builders of power generators, the Allis-Chalmers Company spent considerable time and utilized the best talent in the thorough investigation of gas engines of high power, with the result that it has acquired sole rights for, and is now building in the Edward P. Allis Works at Milwaukee, the Nürnberg gas engine illustrated herewith. This engine is built in units ranging from 130 to 6,000 brake hp to operate with all classes of gaseous fuel, and is adapted to all work that can be performed by a stationary steam engine, including the driving of alternating-current generators for light and power purposes. The Nürnberg gas engine is of the four-cycle system and double-acting type; it embodies the latest improvements which make for reliability, efficiency and permanency; and its builders give the most stringent guarantee in reference thereto.



NÜRNBERG GAS ENGINE.

A glance at the cut will indicate a few of the main features in which the Nürnberg gas engine is a striking improvement upon the familiar gas engine of the last decade. It is double-acting, like a modern steam engine, and will, therefore, develop the same power with a cylinder of one-half the cubic contents required by the older type, while an equal number of Nürnberg cylinders will give the crank shaft a double number of impulses. In its standard construction, with two cylinders placed in tandem and a single set of transmitting parts, the engine utilizes these parts to their full extent, instead of to the extent of only 25 per cent., as is the case in the ordinary single cylinder, single-acting gas engine; and the Nürnberg gas engine accomplishes this without increasing the maximum stresses to which the moving parts are subjected. The valves are operated by means of eccentrics in place of the noisy and short-lived, old-time cams. The pistons are positively supported by outside cross heads running on cool slides, so that the cylinder walls are not called upon to bear any weight, whereby their efficient lubrication and permanent tightness are assured. The inlet and governing valves and their gearing are readily accessible and always in sight, while the exhaust valves are located at the lowest point of the cylinder, to insure the expulsion of such solid matter as may be carried into the cylinder by the gas, or result from carbonization of the lubricant. The cylinder heads can be removed and replaced without the disconnection or deranging of any part of the valve gearing, and, likewise, the pistons may be withdrawn from their cylinders examined, and fitted with new rings, without disturbing any valve mechanism, or even the metallic packing of the piston rods. In a similar manner access to the inside of the cylinder and valve chambers is rendered easy and quick. All parts of one cylinder are interchangeable with any corresponding parts of all other cylinders of the engine.

The regulation is most effective and simple. It is attained by the use of an ordinary high-grade, fly-ball governor, and by a novel construction which combines close regulation with high efficiency under light loads; the whole effect being very similar to that of a modern steam engine.

The crank shaft is journaled in bearings of special construction, giving firm support without undesirable rigidity. Great care has been exercised to allow all parts of the engine full freedom to expand and contract without endangering its perfect alignment. Unusually extensive and carefully distributed water-cooling is provided for, and all important moving parts are automatically lubricated under pressure, for which purpose special oil pumps are furnished.

The Nürnberg gas engine is not in any sense of the term an experiment, for it has been thoroughly developed, perfected and proved by its original designers and builders in Germany. Its introduction into this country by a manufacturing establishment of the high standing earned and enjoyed by Allis-Chalmers Company is a sufficient guarantee of its design and construction.

Blind Telephone Operator.

It is stated that Mrs. Post, of North English, Ia., who is totally blind, successfully manages the local telephone exchange with over 300 subscribers. Each line is provided with a special bell of a special tone, and those bells are all mounted in a cabinet a few feet from the switchboard. There are large bells, small bells, wire clock gongs, sleigh bells and high-keyed bicycle bells. A fine bit of steel wire four inches long is soldered to each bell hammer, and a square sheet of paper attached to this wire bears the line, name and number, forming a visual signal for the assistant operator, who can see. The bell cabinet is so situated that the paper squares may be plainly seen from the operator's seat. Mrs. Post is able to distinguish not only each one of the forty-five bells by its peculiar tone, but also the voices of hundreds of men, women and children whom she serves. She is a graduate of Iowa College for the Blind, and was noted at that institution for quick and retentive memory. We ought to hear next of a deaf telephone operator—in an automatic exchange.

The Heany Arc Lamp.

Since the Heany arc lamp was described in these pages just about a year ago, a number of changes and improvements have been made in it, which are worthy of note. To begin with, it may be mentioned that the supporting stays are made of ⅜-in. tubing instead of 5/32-in. rods. The lamp has been provided with a top casting, on which is mounted a substantial switch and binding posts. The binding posts are mounted on porcelain, and have — and + signs plainly visible. They have also large binding screws and wire holes large enough to accommodate No. 6 wire. The resistance wire is wound on a porcelain ring which surrounds the supporting tubes; the porcelain ring is cut with a thread of 10 pitch, and the wire is wound in this thread. A novel vice-like clamp slides in a slot in the porcelain ring to cut in or out the resistance wire for various line voltages. The solenoid spool is held on the supporting tubes by six strap clamps, instead of screws, as in the old lamp.

The dash-pot in the earlier lamp was made of drawn tubing, the new is cast and reamed, increased from ½-in. to ⅝-in., and is fastened to one of the supporting tubes with a clamp, the supporting tube being provided with a locating pin, which brings the dash-pot to the proper place. In the old lamp no provision was made for locating the dash-pot, and in the hands of inexperienced persons might have caused trouble. In the new lamp any one can place the dash-pot in position. The clutch is made entirely of stampings, instead of castings.

The carbon receiving tube has been increased in diameter from ⅝-in. to ¾-in., so that ½-in. carbon may be used if desired, and to interchange with the other types of Heany lamps. In fact, in improving the lamp this point has been carefully considered, and the casing, carbon receiving tube, supporting tubes, globes and all principal parts will interchange on all the types.

The casings are made of solid copper, and well ventilated, as well as weather-proof. The lower carbon holder has been provided with a cam to lock the carbon, instead of a screw, and has a projection which limits the weight of carbon and is of importance in trimming. The spider on base of the old lamp has been dispensed with and a projection from the base of the lamp takes its place.

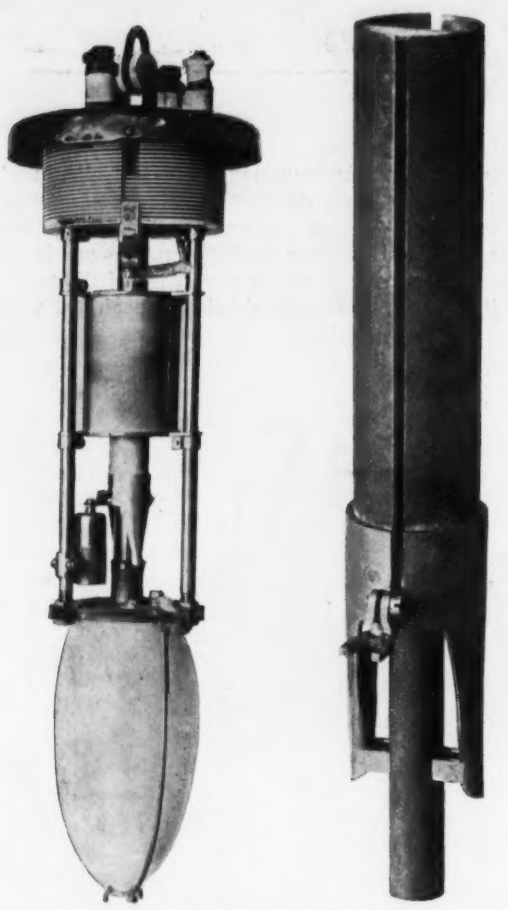
In the old lamp the carbon was exposed partially; in the new lamp this space is closed, making a bearing for the carbon, and preventing admission of oxygen to the inner globe, prolonging life of carbons, and at the same time simplifying the construction.

The internal parts are copper and nickel-plated to prevent corrosion and oxidation. Mica and porcelain are used throughout as insulation.

Telephone "Express" Switchboard.

The International Telephone Manufacturing Company of Chicago has produced a mechanical self-restoring drop or "express" type telephone switchboard claimed to embody in its construction many new and important features. The new board is made up in any capacity, ranging from the small village sizes to those of one thousand lines, the larger equipments being provided with the necessary trunking, or transfer, systems, which may consist of the common method of equipping the various sections with trunking jacks and order-wire keys, or the more elaborate equipment of flash lights, trunking cords, etc. Each operator's position, or section of cabinet, is provided with either one hundred, one hundred and fifty or two hundred lines. Fig. 1 shows the board equipped for one hundred and fifty lines divided into three panels of fifty lines each.

The entire equipment is mounted in a highly polished quarter-sawed golden oak cabinet with five-ply hinged key shelf, hinged double panel back, and with a substantial brass foot-rail. On the hinged shelf are mounted the well-known "International" keys having all the terminals at one end, thus making it possible to contain all of the wiring in one key cable and leaving all of the springs and contact points easy of access and inspection. The plug board is covered by heavy belt leather stained to match the wood-work. In the front of the board and immediately under the key shelf are mounted the necessary night alarm and power generator switches, which are of the locking plunger type with the buttons almost flush with the woodwork. The hand generator is mounted in the back of the cabinet on a substantial shelf which serves the triple purpose of a mounting for the generator, the cord terminals and that of adding strength and rigidity to the frame.



FIGS. 1, 2 AND 3.—ARC LAMP.

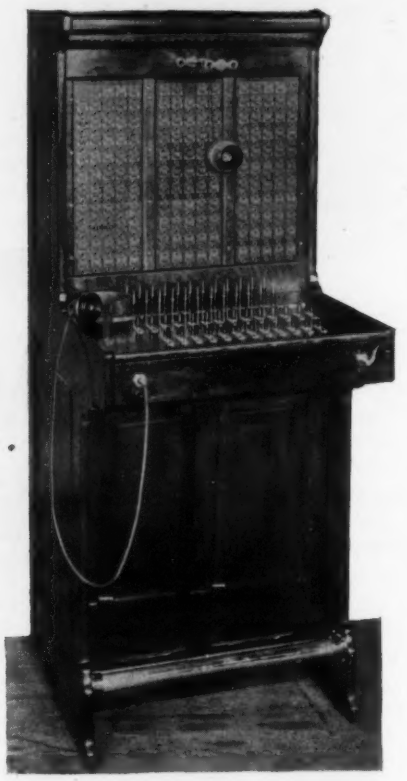


FIG. 1.—"EXPRESS" SWITCHBOARD.

The combined drops and jacks are mounted in strips of five on strong steel plates, as shown in Fig. 2. These supporting strips in turn are securely fastened to a well-constructed steel frame by means of heavy machine screws which are covered by wooden stile strips stained and finished to match the cabinet.

A side view of the drop and jack is shown in Fig. 3. The drop shutter is mounted on the front of the steel mounting plate and the

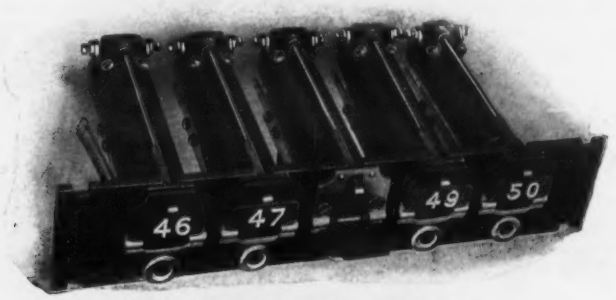


FIG. 2.—STRIP OF DROPS AND JACKS.

back plate of the shutter has part of the stock formed out at the bottom to provide a positive stop for the shutter to prevent its falling far enough to cover the jack.

The drop is of the non-inductive tubular type and is mounted on the base of the jack by means of two screws. The jack springs are of the best grade of German silver and are made of very heavy stock. Near the front they are brought strongly against an insulated stop pin which makes it possible to give them a heavy tension in their normal position and insures a positive plug contact at all times with but the slightest displacement, or bending, of the springs. The jack springs are mounted on the brass cast base and are firmly clamped by heavy machine screws and properly formed washers. The insulation is of mica. The combined drop and jack are mounted on the steel strip by the use of a threaded jack ferrule which passes through the strip from the front of the board into the end piece of the brass jack base. This form of insulation makes it possible to remove any one of the drops and jacks from the front of the board in the smallest fraction of a minute and without disturbing the drop shutters or any other line equipment. A small friction wrench which fits firmly into the jack ferrule is used for this purpose. The tubular drop covering or shell is provided with a guide pin, thus making it impossible to place the coil in any other than its proper position.

The drops and jacks are perfectly insulated from the frame and the mounting strip by a heavy mica sheet and with hard rubber bushings for the jack ferrules and binding screws. This method assembling

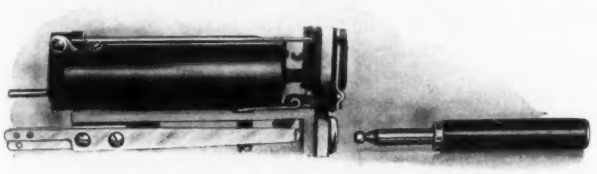


FIG. 3.—DROP AND JACK.

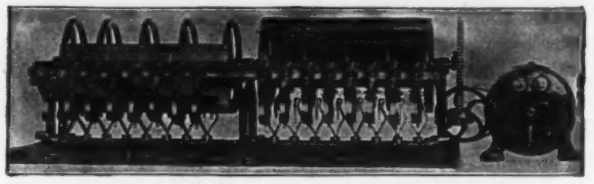
and construction absolutely prevents cross talk and other inductive troubles. The shutter restoring trigger is also mounted on the base of the jack by means of a heavy German silver compensating spring, the peculiar construction of which makes it absolutely impossible for the drop to ever fail to restore. The night bell spring is mounted immediately above the restoring trigger and is brought into connection with the night bell contact by the falling of the drop and the consequent raising of the trigger. The night bell contacts for each bank of five drops are made of one solid brass strip which leads out to the end of the mounting strip where connection is made by a small spiral spring to the common night bellstrip which is placed in the rear of the board in an accessible position between the drop panels or immediately back of the stile strips. It is provided with small hooks so that the night bell circuit of each bank of five drops may be easily disconnected for testing.

The boards are wired full metallic throughout and for their full capacity. They are provided with sufficient cable to reach the lightning arrester or distributing rack. The cables may be either permanently soldered to the line equipments or to clips, in which latter event connection is made by means of screws and washers. Each part of the apparatus is constructed with special tools and dies so that all like parts are exactly uniform in size, shape and form. This makes it possible to assemble the complete equipment without in any way altering or filing any of the parts and insuring accuracy and permanency of adjustment.

Improvements in Sign Flashers.

It is frequently the case that electrical apparatus has to go through a considerable evolution before being reduced to its simplest form. This seems to have been the case with sign flashers. An improvement in the direction of simplicity and more satisfactory operation has recently been made in the design of the electric sign flashers made by the Reynolds Electric Flasher Manufacturing Company, of Chicago. As flashers were formerly made, each make-and-break switch was operated by a cam or segment bolted to a wheel. There were as many of these wheels with cams as there were make-and-break switches on the flasher.

The new design does away with these cams and substitutes a segment of a sheet steel cylinder, which is notched or slotted so as to give the proper combination. This construction is especially an advantage where a number of circuits are to be flashed simultaneously. With the cams it was found difficult to adjust them so

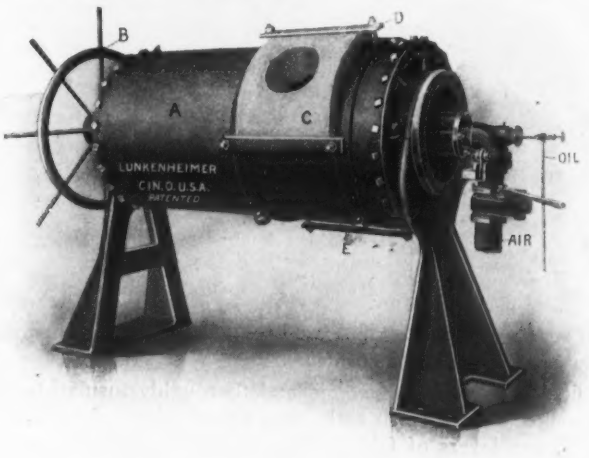


SIGN FLASHER.

they would snap all the switches at exactly the same instant, and the result was a ragged effect on the sign. With the sheet steel it is simply necessary to provide a straight edge in order to have the switches operate simultaneously. If they are not to be operated simultaneously, the edge is notched. The accompanying illustration shows a flasher which is adapted to flash two views of a sign alternately, the circuits on each half being all lighted and extinguished at the same instant. Another advantage of this construction is that there need not be a wheel on the shaft for each switch. It is only necessary to have enough wheels to support the stiff sheet steel segment.

Metal Melting Furnace.

We illustrate herewith the Lunkenheimer metal melting furnace, which has been found to afford a very efficient and economical method of melting metals, particularly brasses and bronzes. As will



MELTING FURNACE.

be seen from the cut above, the furnace consists of a cylindrical sheet-steel drum, *A*, having cast-iron heads. The interior of the drum is lined with fire-proof tile, and there are two openings on

opposite sides of the drum. Only one of these openings is in use, the other being closed by a fire clay filling. The object of having two openings is to increase the life of the linings of the furnace. It has been found that the furnace wears out quicker around the filling hole (which also serves as outlet for the flame) than elsewhere. The advantage is that, when one filling hole is worn out this can be closed by a fire clay filling and plate, the furnace reversed and the other hole cut out and put in service.

The oil burner is of a special type, designed to give the greatest amount of heat with a minimum consumption of oil. In the Lunkenheimer foundry there are ten of these furnaces in use, and they are able to secure from six to seven heats per working day of ten hours from each furnace. The weight of each heat will average about five hundred and fifty pounds, and the oil consumption varies from two to two and one-half gallons of crude oil per hundred pounds of metal melted. The life of the linings is from three to four hundred heats, this varying with the kind of metal melted.

This furnace is made in two sizes, the No. 1 size having a capacity of five hundred and fifty pounds of metal per heat, and the No. 2 size having a capacity of twelve hundred pounds of metal per heat.

Steel Frame Generators and Motors.

Some excellent apparatus has been produced by the Triumph Electric Company, of Cincinnati, Ohio, and we are now able to illustrate and describe their latest types of steel frame bipolar motors and generators, made as motors in sizes from ½ to 5 hp, inclusive, and as generators from ½ to 5 kw, inclusive.

The crown and pole pieces are made of soft close-grained steel. The poles are accurately fitted and bolted to the crown and are readily removable in case of necessity. Cast-iron yokes, heavily ribbed, are centered against the sides of the crown, and are held firmly in position with bolts. These yokes, by removing the bolts, can easily be rotated, thereby adjusting the machine for wall or ceiling suspension, the oil well always remaining in the proper position. The bearings are of gun metal, of the self-oiling type, and are interchangeable. When desired, end plates are furnished, completely enclosing all of the working parts.

The armature core is built up of thin sheet discs and is mounted on a shaft made of the best hammered steel. These discs are notched, and when mounted on the shaft these notches form slots on the circumference of the core, in which the armature conductors are imbedded. The discs are annealed after punching, and in addition to this are varnished before being assembled on the shaft. The armature conductors are thoroughly insulated from the core, every precaution being taken to protect them from injury. The commutator segments are of pure drop-forged copper and are insulated from each other and from the shell with the very best mica. The commutator shell is so constructed that it is impossible for a segment to become loose and cause trouble, and has wells to prevent the oil from getting under the segments.

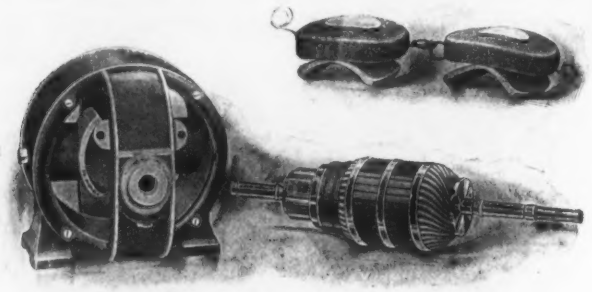


FIG. 1.—ELEMENTAL PARTS OF MOTOR.

The field coils are form-wound and thoroughly insulated. Every coil is soaked in a varnish bath, then baked, after which it is covered with two layers of friction tape, finally receiving two coats of insulating paint.

The brush holders are of the very simplest and most effective design, and of the lightest possible construction consistent with necessary strength and durability. The brushes are of carbon and are fastened rigidly at the end of the holder. As there is no sliding friction of the brush in the holder, the spring has but little weight to move, so that the tension is very light; this results in a very quick and sensitive adjustment of the brush, which eliminates sparking and heating and wearing of the commutator. The holder is clamped to the stud and is provided with a simple and ready means for adjustment if that is ever required. The brushes are properly set in the factory and should not require adjusting under any condition of load, or overload.

The machines are rated well within their limits of capacity, and, as open machines, no part will heat more than 40° C. above the surrounding air, when operated for ten hours under full load. They will withstand an overload of 50 per cent. for a period of one hour, and a momentary overload of 100 per cent. without injury. As entirely enclosed machines the ratings will be somewhat less, to meet these requirements.

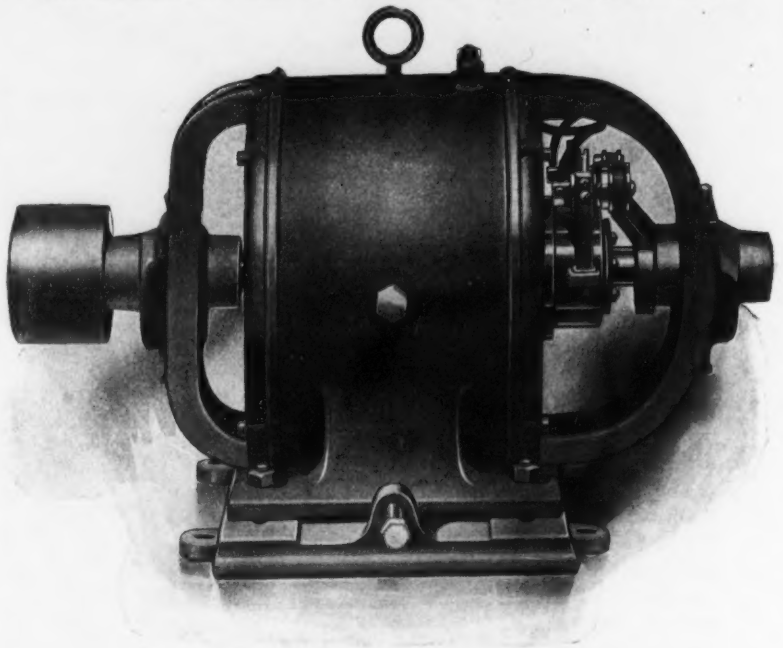
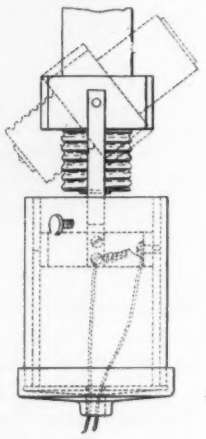


FIG. 2.—STEEL GENERATOR AND MOTOR.

Attaching Plug and Socket.

A patent was recently allowed to Mr. W. H. Kelsey, of the Electric Building, Cleveland, on an attaching plug and lamp socket, herewith illustrated. When this device is made as an electric attaching plug, and the reversing ends contain an Edison or Thomson-Houston plug contact, with electric connections to the supporting arms within the holder, then, by the simple turning or reversing of the ends of the double plug, either the Edison or the Thomson-Houston plug end is presented for attaching to its proper socket. Another feature this device has is the avoidance of twisting the attaching cord. This is avoided by manipulating this plug as follows: Remove the double plug from the holding arms to which are attached the conducting wires, then screw this detached double plug part into the corresponding socket, Edison or Thomson-Houston, then raise the holder in which are the connecting arms with cord attached thereto, and snap these arms tightly to the side contacts on the plug, and the cord remains in its undisturbed state without kinks or twists. Various styles of plugs are made to fit any kind of a single or double-pole socket.



PLUG AND SOCKET.

When this device is made as a lamp socket, the removable reversible part contains two sockets, an Edison and a Thomson-Houston, one on each end, either of which may be turned outward, as is the case with the plugs above described. Therefore, either lamp may be used in this double socket. In addition to this feature of reversibility the device can be made to hold these lamps either one at a time, or both at the same time, and in multiple or in series, by simply placing them across the opening of the holder. Hence, if desired, two lamps can be burned at the same time, or one lamp and an electric fan, or electric stove, or any two such devices can be placed in multiple or in series with each other.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Quotations closed steady after an irregular reaction due to less favorable Eastern news and profit-taking by professional traders. The manipulative and artificial character of the recent advance and the limited nature of the outside buying have had an effect, while adverse reports on iron and steel trade conditions also influenced the trading. The latter led to a renewal of pressure in the United States Steel securities toward the end of the week, when foreign houses were considrable sellers, both of the preferred shares and the new 5 per cent. bonds. In the electrics and tractions the gains that were recorded last week were largely lost. There was little business done in these securities. Brooklyn Rapid Transit closed at the lowest quotation of the week, namely, 47⅛, this being a net loss of 3⅛ points. Metropolitan Street Railway lost 2 points, closing also at the week's lowest figure—121—the sales aggregating 6,000 shares. General Electric lost practically all of its gain of the week previous, closing at 170⅛, a net loss of 7⅝ points; and Westinghouse common closed at 167, a loss of 5 points. The extreme quotations of this stock were 166½, the lowest, and 173, the highest. Western Union closed at 88½ and was steady throughout the week. American Telephone & Telegraph closed at 128, this being a net loss of ⅛ point and the lowest price of the week. Following are the closing quotations of February 2:

NEW YORK.

	Jan. 26	Feb. 2		Jan. 26	Feb. 2
American Tel. & Cable	85	82	General Electric	175	170
American Tel. & Tel.	128⅛	128	Hudson River Tel.	...	...
American Dist. Tel.	22	22	Metropolitan St. Ry.	122¼	120¼
Brooklyn Rapid Transit	49⅞	45⅝	N. E. Elec. Veh. Trns.	...	...
Commercial Cable	183	175	N. Y. & N. J. Tel.	147⅜	137⅜
Electric Boat	18	18	Marconi Tel.	...	...
Electric Boat pfd.	46	45	Western Union Tel.	88¾	88
Electric Lead Reduction	⅝	1	Westinghouse com.	171	165
Electric Vehicle	10¾	9	Westinghouse pfd.	190	180
Electric Vehicle pfd.	14⅛	13⅛			

BOSTON.

	Jan. 26	Feb. 2		Jan. 26	Feb. 2
American Tel. & Tel	128¾	127	Western Tel. & Tel. pfd.	82	82
Cumberland Telephone	112¼	113	Mexican Telephone	1⅜	1⅛
Edison Elec. Illum.	235	238	New England Telephone	121½	121
General Electric	176	170	Mass. Elec. Ry.	22¼	21⅝
Western Tel. & Tel	10⅛	10	Mass. Elec. Ry. pfd.	79	78

PHILADELPHIA.

	Jan. 23	Feb. 2		Jan. 26	Feb. 2
American Railways	45	44	Phila. Traction	97⅝	97⅝
Elec. Storage Battery	59	59	Phila. Electric	6⅛	6
Elec. Storage Battery pfd.	59	59	Phila. Rapid Trans.	14⅛	14⅝
Elec. Co. of America	8⅛	8¼			

CHICAGO.

	Jan. 26	Feb. 2		Jan. 26	Feb. 2
Central Union Tel.	...	...	National Carbon pfd.	95	70
Chicago Edison	...	150	Metropolitan Elev. com.	17⅛	17
Chicago City Ry	160	165	Union Traction	5¼	5
Chicago Tel. Co.	...	...	Union Traction pfd.	30	30
National Carbon	28	28			

*Asked

TROLLEY IN TEXAS.—Conversion of the Gulf & Interstate Railroad into an electric line and the consolidation of two other electric lines, all three under one control, is reported to have been practically accomplished by John W. Gates and his associates. It is said that the new company has practically consummated a deal whereby it will take the Gulf & Interstate, which is the short line between Galveston and Beaumont. At Beaumont this road will connect with the Beaumont & Sour Lake electric line and later join the projected Port Arthur & Beaumont electric line, of which Gates is the founder. Gates is largely interested at Port Arthur and in the oil fields, and the Port Arthur road will be started within a few weeks. The Gulf & Interstate runs through a productive territory, and is 74 miles long. With the three lines consolidated, the electric system would traverse the oil, lumber and rice section of East Texas with a Gulf outlet at Galveston and Port Arthur. It is also stated that another electric line is projected from Beaumont, which will be the center of the system, northeast to the Jasper gold field. It is said that the project will involve nearly $2,000,000.

CHICAGO TELEPHONE.—The Chicago (Bell) Telephone Company reports as follows for the year ended December 31, 1903:

	1903.	1902.	1901.	1900.
Gross	$5,534,590	$4,570,806	$3,775,002	$3,129,238
Expenses	4,113,246	3,368,335	2,691,129	2,258,780
Net	$1,421,344	$1,202,471	$1,083,873	$870,458
Dividends paid	1,274,835	1,075,193	960,000	749,808
Surplus	$146,509	$127,278	$123,873	$120,650
Cash on hand	547,640	134,706	.....	.....

Assets of the company show an increase of $2,348,475, making a total of $15,251,354. During the year $1,428,320 was invested in a new plant. There was an increase of $2,007,000 in stock issue. The report is considered excellent. No changes were made in the directorate. The Chicago Telephone officials say the earnings from extensions easily guarantee the regular dividends on the new stock issue, which will be at par as usual.

DETROIT TROLLEYS ANNUAL REPORT.—The Detroit United Railway system reports as follows for the year ended December 31, 1903:

	1903.	1902.	1901.	1900.
Gross	$4,386,975	$3,961,403	$2,919,171	$2,575,276
Ex. and tax.	2,613,977	2,260,786	1,596,765	1,439,057
Net	$1,772,998	$1,700,617	$1,322,406	$1,136,219
Other income	38,863	31,247	23,067	14,559
Total income	$1,811,861	$1,731,864	$1,345,473	$1,150,778
Charges	1,000,000	948,902	675,344	638,317
Surplus	$811,861	$782,952	$670,129	$512,461
Dividends	500,000	500,000	500,000	.....
Surplus	$311,861	$282,952	$170,129	$512,461

The above includes Detroit United Railway, Rapid Railway System and Sandwich, Windsor & Amherstburg Railway. Over $1,200,000 was spent on betterments for the entire system during the year. The system carried 104,018,886 passengers, the average receipts being $0.358 per passenger. The car mileage made was 19,114,970 miles.

BROCKTON LIGHTING ANNUAL.—The annual report of the Edison Electric Illuminating Company, of Brockton, Mass., shows as follows:

	Nov. 30, '03.	Nov. 30, '02.	Increase.
Gross earnings	$104,967.24	$95,044.93	$9,922.31
Operating expenses	71,721.15	61,567.86	10,153.29
Net earnings	$33,246.09	$33,477.07	*$230.98
Fixed charges	11,347.82	8,920.88	2,426.94
Net profit	$21,898.27	$24,556.19	*$2,657.92

* Decrease.

LOWELL ELECTRIC LIGHT REPORT.—The annual report of the Lowell (Mass.) Electric Light Corporation shows as follows:

	Nov. 30, '03.	Nov. 30, '02.	Increase.
Gross earnings	$230,854.72	$207,298.26	$23,556.46
Operating expenses	153,128.27	130,177.31	22,950.96
Net earnings	$77,726.45	$77,120.95	$605.50
Fixed charges	12,724.43	13,587.33	*862.90
Net profit	$65,002.02	$63,533.62	$1,468.40

* Decrease.

MINNEAPOLIS LIGHTING ANNUAL.—The Minneapolis General Electric Company reports as follows for the past year:

	Nov. 30, '03.	Nov. 30, '02.	Increase.
Gross earnings	$551,711.29	$496,122.03	$55,589.26
Operating expenses	308,832.96	257,311.66	51,521.30
Net earnings	$242,878.33	$238,810.37	$4,067.96
Fixed charges	110,021.52	97,803.92	12,217.60
Net profit	$132,856.81	$141,006.45	*$8,149.64

* Decrease.

DIVIDENDS.—The New England Telephone & Telegraph Company has declared its regular quarterly dividend of 1½ per cent. to stock of record January 30. Books close February 1 to February 13, inclusive. The North American Company has declared a 5 per cent. dividend, payable in quarterly instalments. This is an increase of 1 per cent.

NEW YORK AND NEW JERSEY TELEPHONE COMPANY.—The directors of the New York & New Jersey Telephone Company have voted to offer at par to the stockholders $1,252,000 of the unissued stock of the company. The offer will be in proportion of one share for each ten shares held, and expires on March 1.

AMERICAN DISTRICT TELEGRAPH.—The American District Telegraph Company, of New York, reports as follows for the year ended December 31, 1903:

	1903.	1902.	1901.	1900.
Revenue all sources	$577,676	$610,043	$624,194	$590,536
*Operating expenses	511,808	513,176	535,544	503,690
Net	$65,868	$96,867	$88,650	$86,846
Dividends	76,888	76,886	96,107	86,497
Deficit	$11,020	Sur.$19,981	$7,457	Sur.$349
Miles wire	1,552	1,552	1,548	1,537
Offices	85	85	85	86
Instruments	29,143	27,940	27,905	27,943

*Includes construction expense.

The general balance sheet as of December 31, 1903, compares as follows:

Assets:	1903.	1902.
Plants, patents, stocks merged, etc.	$4,052,997	$4,018,865
Stocks and bonds, companies not merged	207,540	235,700
Supplies and uniforms	34,204	21,413
Sundry accounts receivable	58,884	46,487
Advances	90	746
Due from managers	7,669	22,241
Due from agents	1,234	2,023
Cash	21,778	18,725
Total	$4,384,397	$4,366,200
Liabilities:		
Capital stock	$3,844,700	$3,844,700
Sundry accounts payable	27,239	7,260
Contingent liabilities	8,830	5,940
Profit and loss surplus	503,628	508,300
Total	$4,384,397	$4,366,200

President Robert C. Clowry says in part: "The revenues of the company were effected by the distinctly unfavorable local conditions which prevailed throughout the year. The loss is largely in earnings from messenger service and has as far as possible been offset by reductions in the expenses, aggregating $22,025. The work of improving the company's plant has been steadily pursued. This work, together with the cost of wiring new buildings connecting new subscribers, fitting up new offices, etc., amounting in all to $34,508, has been paid out of current earnings and surplus."

MICHIGAN STATE TELEPHONE.—The Michigan State Telephone Company has filed articles of incorporation in Michigan with a capital stock, all paid in, of $25,000, par $100, divided into $10,000 6 per cent. cumulative preferred and $15,000 common. The right is reserved to increase the capital stock. The voting powers of the common and preferred are equal. The incorporators and directors are: William A. Jackson, founder of the Michigan Telephone Company, who will probably be president of the new company; John T. Shaw (vice-president), cashier of the First National Bank; James Cullen and Elliott G. Stevenson, partner of Don M. Dickinson, counsel for the bondholders of the Michigan Telephone Company here. This is a preliminary step to the reorganization of the Michigan Telephone Company. Much Detroit capital is believed to be going into the new concern. When the regular company is organized the present new company will be dissolved. The minority interests in Michigan Telephone have not yet filed an appeal. They say they may, but it is believed they will not. This step indicates progress on the part of the bondholders.

NORTH AMERICAN DIVIDEND.—A dividend of 5 per cent. for the year was declared last week by the directors of the North American Company, this dividend representing an increase of 1 per cent. over that paid during the past year. That such action would be taken had long been predicted in Wall Street, where for some time it had been said that the earnings jusified a larger distribution upon the company's stock. In connection with the increased dividend it is explained that the policy of the company is to declare dividends out of its fixed income derived from interest and dividends receive from its investments, while earnings from other sources are employed to increase the company's surplus or for the development of the company's light and power properties. The present capitalization of the North American Company is $17,000,000, to which amount it was last year increased from $12,000,000. In 1901 the capital stock had been reduced from $40,000,000 to $12,000,000. The dividend declared is payable in four quarterly installments of 1¼ per cent. each, beginning March 1.

STANDARD UNDERGROUND CABLE.—The annual report of the Standard Underground Cable Company shows gross business for 1903 of $9,192,618, and net earnings of $704,438, or about 35 per cent. on the company's $2,000,000 capital. Dividends amounting to 12 per cent. were paid, leaving $474,706 to add to surplus, which now amounts to $1,229,112. The company's business for 1903 was more than double that of 1902. The company has no outstanding notes, mortgages, bonds or preferred stock, and no contingent liabilities on business paper of customers. The mills of the company handled during 1903 copper equal to 5 per cent. of the total production of copper of the entire North American continent for that period. On December 31, 1903, the company had unfilled orders amounting to over $1,000,000, and orders have been booked since that date amounting to over $600,000.

SOUTHERN NEW ENGLAND TELEPHONE.—The Southern New England Telephone Company reports for the year ended December 31, 1903, as follows:

	1903.	1902.	Changes.
Gross	$1,098,289	$919,556	Inc. $178,733
Expenses	897,226	746,812	Inc. 150,414
Net	$201,063	$172,744	Inc. $28,319
Dividends	187,050	172,500	Inc. 14,550
Surplus	$14,013	$244	Inc. $13,769

At the annual meeting of the stockholders the retiring board of directors was re-elected. The increase in the amount of business during the year was the greatest in the company's history. Of the capital stock of $3,500,000, the American Telegraph & Telephone Company owns $955,400.

SOUTH SIDE ELEVATED.—The South Side Elevated, of Chicago, reports as follows for the year ended December 31, 1903:

	1903.	1902.	1901.	1900.
Gross	$1,679,310	$1,483,843	$1,362,231	$1,286,638
Expenses and taxes	994,376	862,338	844,960	748,482
Net	$684,934	$621,505	$517,271	$538,236
Interest and dividends	442,883	442,874	391,705	340,515
Surplus	$242,051	$178,631	$125,566	$197,721

President Carter, in his annual report, outlined the plan to issue $7,000,000 new stock to stockholders at about 93, payable in three equal quarterly installments, viz.: April 30, 1904; April 30, 1905, and April 30, 1906. The stock is to be issued on the last payment.

LEHIGH VALLEY TRACTION.—The Lehigh Valley Traction reorganization committee expect within a few weeks to have the audit report of the American Audit Appraisement Company for the last half of the year 1903. They will then, it is stated, be prepared to offer a reorganization plan within a reasonably short time. This has been delayed because 1902 was an unusually bad year on account of flood damages, and it was desired to base the plan on a normal year such as 1903 has been. The physical examination of the properties by Mr. Foster was completed months ago. Signatures are being obtained from Philadelphia & Lehigh Valley Traction bondholders to a written agreement favoring the application for the proposed issue of about $160,000 receivers' certificates.

AUGUSTA RAILWAY & ELECTRIC.—Mr. James U. Jackson has completed arrangements by which the control of the Augusta-Aiken Company, the Augusta Railway & Electric Railway Company, Augusta & Aiken Railway Company, North Augusta Land Company and all the interests which Mr. Jackson organized in and around Augusta, are to be reorganized, controlled entirely by Augusta people, with himself as president. A year or so ago Mr. Jackson completed a transaction by which a majority interest in the Augusta Railway & Electric Company was secured by the Augusta-Aiken Railway, and now he has also purchased the minority interest, and both companies will be under one management. The transaction required the raising of about $1,000,000.

NORTHWEST ELEVATED OF CHICAGO.—The Northwest Elevated, of Chicago, reports as follows for the year ended December 31, 1903, as the result of electric traction:

	1903.	1902.	1901.
Gross	$1,542,039	$1,410,998	$1,100,863
Operating expenses	345,247	464,401	376,140
Net	$996,792	$946,597	$724,723
Charges	794,257	757,173	565,435
Surplus	$202,535	$189,424	$159,288

UNITED GAS & ELECTRIC.—The income account of the constituent companies of the United Gas & Electric Company for the year ended December 31, 1903, follows:

	1903.	1902.	Changes.
Gross	$1,224,047	$1,115,297	Inc. $108,750
*Expenses	1,010,363	914,887	Inc. 95,476
Net	$213,684	$200,410	Inc. $13,274

*Includes all costs of operation, insurance, taxes, depreciation and interest.

PITTSBURG BELL TELEPHONE.—The annual meeting of the Central District & Printing Telegraph Company will be held in Pittsburg February 11. The question of increasing the capital stock from $10,000,000 to such an amount as may be decided upon at the meeting will be submitted for the approval of the stockholders. Of

the $10,000,000 stock outstanding, the American Telephone & Telegraph owns $6,191,290.

COMMERCIAL CABLE.—Reports show that Commercial Cable stock has recently been active and higher in Montreal on purchases growing out of the steadily increasing earnings and particularly because of the large business of the new Pacific cable and the promise of large earnings as war news becomes more important. The company has been extending its business by putting earnings into new construction which has added largely to equity values.

LONG ISLAND TROLLEY MORTGAGE.—The Central Long Island Electric Railroad, which purposes to operate from Port Jefferson to Patchogue, L. I., has been granted authority by the New York State Railroad Commission to issue a mortgage on its property for $500,000. The Ithaca-Cortland Traction Company has been authorized to issue a mortgage for $650,000. The companies are to use the proceeds of the mortgages for purposes of construction.

CINCINNATI STREET RAILWAY.—The next dividend on Cincinnati Street Railway stock in April will be at the rate of 6 per cent. per annum, guaranteed by the Cincinnati Traction Company. The dividend has been graduated from a 5 per cent. rate covering a period of several years.

STROWGER TELEPHONE.—The directors of the Strowger Automatic Telephone Company have issued a statement to stockholders saying the company is prosperous and that the dividend rate of 1 per cent. yearly will be increased shortly.

Commercial Intelligence.

THE WEEK IN TRADE.—Reports received by the mercantile agencies indicate that the weather conditions have been unfavorable throughout a wide area, and while in some instances helpful to retail trade, extreme cold or heavy snows have rather sharply checked spring trade and retarded transportation. There is also a quieter feeling in several lines of speculation and of industry, the exception to this being found in the south where, stimulated by the extraordinarily high cotton prices, preparations for the planting of an enormous acreage are going forward. A turn in the tide of speculation occurred and brought about lower prices for most of the cereals and securities. Staple prices, however, are generally very strong. Reports from the iron and steel trade are somewhat unsatisfactory. The railroads are still out of the market for rails, and finished products except at a few western markets are rather duller. A despatch received during the week from Montreal stated that the Pennsylvania Steel Company had obtained a contract from the Canadian Pacific Railway for 40,000 tons of 80-lb steel rails at $21.50 a ton, and that the United States Steel Corporation had also quoted for the contract at the same figure, but had failed to secure it. Structural material is quiet, but there is an active demand for wire, wire products and tubing at Pittsburg. Lumber and kindred industries are very active at all southern points. The pig iron production for 1903 surpassed expectations, the large decrease of the second half having been offset by the immense production of the first six months. The total output—18,009,000—exceeded by one per cent. the record production of 1902. Copper prices declined, but otherwise the situation is unchanged. The official quotations are: Lake, 12⅝ to 12⅞c.; electrolytic, 12½ to 12¾c.; and casting stock, 12⅜ to 12⅝c. Outside lots can be purchased at concessions from these figures of about ⅛ cent. The exports have been going on at an unexpected rate. It was noted last week that the total shipment for the month would probably reach 20,000,000 tons, and notwithstanding this heavy drain upon the available supplies, the metal was freely offered. This is taken to indicate that there are ample stocks in the hands of producers. The business failures for the week ending January 28, according to *Bradstreet's*, aggregated 242 against 266 the week previous, and 230 in the corresponding week last year.

EUREKA TELEPHONE EQUIPMENT.—The Belvidere Telephone Company, at Belvidere, Ill., in order to meet its service and render it more rapid have contracted with the Eureka Electric Company, of Chicago, and Genoa, Ill., to equip the 800-line express switchboard which it now has with the Eureka flashlight transfer system, consisting of 56 trunking lines having lamp signals at each end of the trunk. This trunking system will be able to accommodate 1,000 lines, as there will soon be that number in use. This board is also to be equipped with new listening and ringing keys and Eureka flashlight supervisory. The addition of the above apparatus gives the operator complete flashlight supervision over all calls, both trunking and those in her own section, and will greatly facilitate her work, enabling her to take care of more calls than would otherwise be possible. Among recent shipments are one Eureka magneto express switchboard of 400 capacity to McPherson Telephone Company, McPherson, Kan.; one 100-capacity board to Lawton Telephone Company, Lawton, Iowa; one 100-capacity board to Indiana Electric Company, Hillsdale, Ind.; one 100-capacity board to Citizens' Mutual Telephone Company, Newport, Ind.; one toll line board to J. E. Briglin, Orleans, N. Y.; one 100-capacity board to Larue Co. Telephone Exchange Company, Hodgenville, Ky.; one combination telephone and switchboard and one 100-capacity board to Quincy Mining Company, Hancock, Mich.; one 100-capacity board to Jas. A. Helm, De Soto, Ill.; one 100-capacity board to Chas. Causey, West Union, Ind.; one 100-capacity board to Mitchell Telephone Company, Georgia, Ind.; one 50-capacity board to Theresa Union Telephone Company, Theresa, Wis.; one 25-capacity board to Morgantown Telephone Company, Morgantown, Ind.; one combination telephone and switchboard to J. W. Reynolds, Simpson, Ill.; also a large shipment of telephones for Valparaiso, S. A., and a shipment of 100 telephones for San Salvador, C. A.

SOME C & C ORDERS.—The C & C Electric Company, 143 Liberty Street, New York City, reports recent receipt of British and African orders for motors. The British orders were secured through C. R. Heap, of London. A 45-hp series parallel equipment has been requisitioned for hoisting machinery in South African gold mines. The company has a number of domestic orders in hand for equipment to be installed in hotels, manufacturing plants, private residences, printing plants, etc. The Hotel Albert is to be equipped with two 60-kw and one 40-kw generator. These generators will be direct-connected to Payne engines of 90-hp and 60-hp capacity. This equipment will be used for lighting the hotel and driving the elevators. The Coco Cola Company, of Chicago, has ordered a 50-kw generator and marble switchboard. The generators will be direct-connected to a Shepherd vertical engine of 75-hp capacity. This outfit will be utilized for both light and power purposes. A 75-kw belted generator and switchboard has been ordered for light and power use in the quarries of William Bradley & Son, of Bedford, Ind. A 12½-kw generator has been called for, for direct connection to a Nash gas engine for lighting a private residence at Ossining, N. Y. A special slow-speed motor will be used for driving a large blower in the Union County Court House, Elizabeth, N. J. A 100-hp series parallel equipment has been ordered for driving a big Goss color press in the New York *Herald* plant.

COPPER IN ENGLAND.—The annual copper review of James Lewis & Son, of Liverpool, presents the following statistics of the total consumption of copper in the principal countries of Europe:

	1903.	1902.	1901.	1900.
Consumption of England	60,637	84,377	76,946	81,376
Manufactured copper exported ..	25,745	22,145	16,765	16,100
Sulphate of copper exported	13,361	10,822	9,004	10,728
Consumption of France	45,147	49,254	39,883	42,436
Consumption of Germany	*79,000	71,514	52,885	77,146
Consumption Am. copper in Italy, Austria and Russia	13,513	14,802	6,638	8,863
Total tons	243,403	252,914	202,121	236,649

* December estimated.

The circular says: "Our statistics of consumption for the year show an increase in the United States of 2,700 tons, and in Germany of about 7,500 tons, but a decrease in England of 17,740 tons and in France of 4,107 tons. The exports of manufactured copper (chiefly to India) and of sulphate have increased 6,139 tons. There is, however, little doubt that the actual consumption of England has not fallen off, but on the contrary has increased, the above apparent decrease being due to the greatly reduced stocks held by smelters and manufacturers. Much more copper has been used for electrical purposes; an increased quantity of sulphate has been consumed in Ireland, and though there is a decrease of 206,605 tons in the ships launched, there is an increase of 65,791 tons in the indicated horse-power of the marine engines supplied to them."

TORPEDO CABLE FOR JAPAN.—The Safety Insulated Wire and Cable Company, 114 Liberty Street, New York, reports brisk business. The New Haven plant of the company has been working at high pressure both night and day for some time past, and the Bayonne, N. J., works will begin continuous operation within the next few days. The Japanese Government has just requisitioned for a large lot of torpedo cable. A contract has been secured from the Philippine civil government for 30 miles of standard type cable which will be utilized to connect the last of the numerous islands with the mainland. The Safety Insulated Wire and Cable Company has taken contracts from the same source which will represent in all nearly 2000 miles of cable. The United States War Department has ordered a big quantity of range-finder cable for use in different fortifications along the Atlantic, Pacific and Gulf coasts. The company will ship next week 13 miles of single conductor cable to be used for connecting the fortifications of Puget Sound with Seattle, Washington.

THE WARREN ELECTRIC COMPANY, of Sandusky, Ohio, is shipping a 10,000-light generator to Martinsburg, W. Va.

GAS ENGINE POWER PLANTS.—The Power & Mining Machinery Company, of 52-54 William Street, New York City, reports some important recent work, especially for the Elmira (N. Y.) Water, Light & Railroad Company. Its contract with that company covers a four-cylinder American Crossley gas engine of the opposed type, with cylinders 32 in. in diameter x 36 in. stroke, to run 138 r.p.m. and to develop, under normal load, 1,300 brake hp, with natural gas containing 1,000 B.T.U. per cu. ft. This engine will be direct-coupled to a General Electric 60-cycle alternator of the fly-wheel type, and will run in parallel with their existing steam engines and with such other gas engines as they may install in the future. This engine will be used for both lighting and power; the direct current for their railway work secured by the use of rotary converters. The above order was placed after the Elmira Water, Light & Railroad Company had thoroughly investigated the gas engine field for over a year. In addition to the above, it has entered the following recent orders: Milford Electric Light Company, Milford, N. H., one 80-brake-hp high-speed Crossley gas engine, with cylinders 17 in. x 24 in., and one Crossley suction type producer plant of the same capacity. The Motor Engine Company, 15 William Street, New York City, one 20-brake-hp Crossley new type suction gas producer, to be installed at its Staten Island shops. The Ampara Mining Company, Philadelphia, Pa., one 190-brake-hp Crossley high-speed, double-cylinder gas engine, with cylinders 18½ in. x 24 in.; and two high-speed, single-cylinder Crossley gas engines, of 130-brake-hp each, with cylinders 20 in. x 30 in.; six 9-ft. x 15-ft. Loomis generators, with two 10,000 cu. ft. holders.

WESTINGHOUSE TURBINES IN A TEXTILE MILL.—The Westinghouse Machine Company has recently received an order from Joseph Benn & Sons for a turbo-generator set to be used in furnishing light and power for driving machinery in their new alpaca mills, which are to be built at Olneyville, R. I. This factory will be an American branch to their Yorkshire, England, mills. The turbine is of the Westinghouse-Parsons type, of 400-kw capacity, and is to operate under a steam pressure of about 150 pounds. Superheated steam will probably be used. The turbine will drive a 400-kw, three-phase Westinghouse alternator which will deliver power to the motors situated in the various parts of the mill for the purpose of driving machinery in the different departments. A 7½ x 7 Westinghouse standard engine type outfit is also being supplied and will be direct-connected to the generator rig for furnishing the exciter current. F. P. Sheldon & Co., mill engineer, of Providence, are now at work designing the plans for these mills.

LOS ANGELES ELECTRICAL SPECIALTY COMPANY, of 145 West Fourteenth Street, Los Angeles, Cal., has just completed a plant for the manufacture of high-grade dry cells for automobiles, gas engines, telephones, bells and all open-circuit work. The officers are David W. Coons, treasurer, and Arthur W. Coons, superintendent, who say: "With three years' practical experience with manufacturing batteries in the East, and several months spent in German and French battery works, investigating latest and most improved methods, and with the use of the best imported materials, we are able to produce the highest possible grade of cells and batteries for all electrical work where dry cells are used. We make all standard sizes and furnish estimates for special sizes where desired." They are catering primarily to Pacific Coast trade, but will be glad to hear from any part of the country.

THE AUTOMATIC ELECTRIC COMPANY, of Chicago, has recently sold complete telephone equipment for 1,000 stations to the Auburn Telephone Company, Auburn, N. Y. It has also received an order for 800 stations from the Ideal Construction Company, Hopkinsville, Ky. These figures are for present installation, and the ultimate capacity for each exchange will be 10,000 stations. About seven years ago the Auburn company installed an "Automatic" board with an ultimate capacity of 400 stations. This was soon filled, and in order to increase the list of its subscribers it purchased two manual boards of two operators' positions each and connected them with the automatic switchboard by means of trunk lines. The new equipment replaces the old "Automatic" board and the two manual boards which were later installed to give service in conjunction with it.

DENVER TROLLEY POWER HOUSE.—The maximum boiler horse-power in central power stations is only attained during a few hours of the day. During the greater part of the day the capacity required is much less than this maximum. On this account it has been found economical and practical to design the boilers and chimneys of ample capacity for this load and to force them above and up to the maximum by means of mechanical draft. This is applied with equal success to old and new plants. In the new power station of the Denver Tramway Power Company, Denver, Colo., mechanical draft is used as an auxiliary to the natural draft provided by a chimney 240 ft. high. Artificial draft is furnished by three Sturtevant electrically-driven steel plate fans. The boiler capacity of the plant is approximately 6,000 hp.

PAYNE ENGINEERING COMPANY, 26 Cortlandt Street, New York City, has issued recently the following notice, signed by Messrs. H. S. Whitney and M. A. Hudson: "We wish to inform our friends and customers, that we have completed arrangements whereby on January 1, 1904, we assumed the management of the Western business of the Ashcroft Manufacturing Company, the Hayden & Derby Manufacturing Company, the Hancock Inspirator Company and the Consolidated Safety Valve Company. On the same date the management of this company, with which we have been identified for the past eighteen months, was turned over to Mr. W. S. Montgomery."

FAILURES OF JANUARY.—The commercial failures in the United States in January, according to reports received by R. G. Dun & Co., numbered 1,406, with an aggregate defaulted indebtedness of $18,483,573, as compared with 1,269 failures in January, 1903, for $12,978,979. Of the 1,406, 271 were of manufacturers, for $6,687,637. On account of annual payments and inventory disclosures January is usually a month of many failures, but careful comparison shows that losses last month were heavier than in the corresponding month of any year since 1896, and heavier than in any month since May, 1900, excepting only December last.

EQUIPMENT FOR APARTMENT HOUSE.—The Construction Realty Company is about to ask estimates on the power plant to be installed in a new apartment house at Sixty-ninth Street and Broadway. There will be three direct-connected simple automatic high-speed engines, 13 x 12 in. The generators will be direct-current compound-wound multipolar machines, 125 volts, 65 kw. The wiring will be a two-wire 125-volt system. Percival Robert Moses is acting as consulting engineer for the company in this matter.

NATIONAL CARBON COMPANY.—The National Carbon Company, which closed its fiscal year January 31, has now completed the fifth year of its existence. The company has earned and paid dividends on the preferred stock at the rate of 7 per cent. If the company follows precedent it is expected to charge off about $300,000 for depreciation. Up to the last statement January 31, 1903, the company had charged off more than $900,000 since its inception, while the profit and loss surplus, according to the last statement, was only $156,000.

BALL ENGINE ORDER.—The Eastman Kodak Company, of Rochester, N. Y., has contracted with the Ball Engine Company, of Erie, Pa., for two 400-hp. vertical cross-compound engines, to be direct-connected to a 250-kw Crocker-Wheeler generator. The Ball Company has just installed two 350-hp vertical cross-compound, direct-connected units in the First National Bank Building, Chicago, and is also building two additional units of the same size for this plant.

CAHALL BOILERS FOR WORLD'S FAIR PLANT.—The important contract for boilers which will furnish the steam for nearly two-thirds the entire power plant for the World's Fair has just been awarded. The Aultman & Taylor Machinery Company, of Mansfield, O., secured the work. The boilers, 16 in number, will have an aggregate capacity of 7500 boiler hp. They will be installed in the Steam and Fuel Building at St. Louis.

THE GREAT NORTHERN POWER COMPANY, of Duluth, Minn., is asking for proposals for vertical turbines to operate under a head of 365 ft. at 250 r.p.m., together with other necessary apparatus. According to the present plans of the company it is expected to have a 35,000-hp plant in operation in 1905. The plans provide for an increase of power up to 80,000 hp. Another hydraulic installation of 12,000 hp at a 70-ft. dam is also in contemplation.

PELTON WATER WHEELS FOR SOUTH BRAZIL.—The Pelton Water Wheel Company, 143 Liberty Street, New York, has secured a contract for a 300-hp water wheel outfit which will be used for developing power for lighting a small city in South Brazil. The generator—200 kw—will be built by the General Electric Company. The contracts came through Guinle & Aschoff, of Rio Janeiro.

MEXICAN HYDRAULIC PLANT.—The construction of a hydraulic plant is projected on the River Plomosas in the district of Rosario, State of Sinoloa, Mexico. An American, Dell Linderman, who operates extensive mines in that district, is primarily interested in the project. He intends to operate his mines by electric power. The plant will have a capacity of about 1500 hp.

SALE OF LIGHTING PLANTS.—The J. S. Maurer & Co. agency, 804 Monadnock Block, Chicago, reports the sale of central electric light plants, for investment purposes, in the towns of Pecatonica and Pittsfield, Ill., and Blairstown, Iowa.

McCREARY SPECIALTIES FOR EUROPE.—The A. A. McCreary Company, of 136 Liberty Street, New York, has some substantial orders in hand for its electrical specialties for shipment to Mexico City, London and Paris.

DIRECTORY OF ELECTRICAL ASSOCIATIONS, SOCIETIES, ETC.

(Published first issue of each month.)

AMERICAN ELECTROCHEMICAL SOCIETY. Secretary, C. J. Reed, 929 Chestnut Street, Philadelphia, Pa. General meeting, Washington, D. C., April 7, 8 and 9, 1904.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Secretary, Dr. C. E. Skinner, New Haven, Conn.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Secretary, Ralph W. Pope, 95 Liberty Street, New York. Meetings, last Friday each month.

AMERICAN RAILWAY, MECHANICAL & ELECTRICAL ASSOCIATION. Secretary, Walter Mower, 12 Woodward Ave., Detroit, Mich.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS. Secretary, G. W. Tillson, Brooklyn, N. Y. Next meeting, St. Louis, 1904.

AMERICAN STREET RAILWAY ASSOCIATION. Secretary, T. C. Pennington, 2020 State Street, Chicago.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Secretary, W. S. Barstow, New York City and Portland, Ore.

CANADIAN ELECTRICAL ASSOCIATION. Secretary, C. H. Mortimer, Toronto, Ont. Next meeting, Hamilton, Ont., 1904.

CHICAGO ELECTRICAL ASSOCIATION. Secretary, W. B. Hale, 242 South Jefferson Street, Chicago.

COLORADO ELECTRIC LIGHT, POWER & RAILWAY ASSOCIATION. Secretary, George B. Tripp, Colorado Springs, Col. Annual meeting last Wednesday in October.

CONNECTICUT STATE STREET RAILWAY ASSOCIATION. Secretary, E. W. Poole, Bridgeport, Conn. Annual meeting in November.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Secretary, F. P. Ide, Springfield, Ill. Next meeting, December, 1903.

ELECTRICAL TRADES SOCIETY (Member National Electrical Trades Association). Secretary, A. P. Eckert, 39 Cortlandt Street, New York. Board of Directors meets second Friday of each month.

ILLINOIS STATE ELECTRIC ASSOCIATION. Secretary, H. E. Chubbuck, LaSalle Ill.

INDIANA PUBLIC UTILITIES ASSOCIATION. Secretary, A. M. Barron, Indianapolis, Ind.

INDEPENDENT TELEPHONE ASSOCIATION OF THE UNITED STATES. Secretary, Frank G. Jones.

INDEPENDENT TELEPHONE ASSOCIATION OF SOUTHERN INDIANA. Secretary, E. W. Pichardt, Huntingburg, Ind.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Secretary, Frank P. Foster, Corning, N. Y.

INTERSTATE INDEPENDENT TELEPHONE ASSOCIATION. Secretary, E. M. Coleman, Louisville, Ky.

IOWA ELECTRICAL ASSOCIATION. Secretary, W. S. Porter, Eldora, Ia.

IOWA TELEPHONE ASSOCIATION. Secretary, C. C. Deering, Des Moines, Ia. Annual meeting, Des Moines, March 8, 1904.

KENTUCKY INDEPENDENT TELEPHONE ASSOCIATION. Secretary, James Maret, Mount Vernon, Ind.

MAINE STREET RAILWAY ASSOCIATION. Secretary, E. A. Newman, 471 Congress Street, Portland, Me.

MASSACHUSETTS STREET RAILWAY ASSOCIATION. Secretary, Charles S. Clark, 70 Kilby Street, Boston, Mass. Meets second Wednesday of each month, except July and August.

NATIONAL ARM, PIN & BRACKET ASSOCIATION. Secretary J. B. Magers, Madison, Ind. Next meeting St. Louis, July, 1904.

NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION OF THE UNITED STATES. Secretary, W. H. Morton, 44 Whitesboro Street, Utica, N. Y. Next meeting St. Louis, Mo., September 14, 15 and 16, 1904.

NEW ENGLAND STREET RAILWAY CLUB. Secretary, J. H. Neal, 101 Milk Street, Boston, Mass. Meets last Thursday of each month.

NEW YORK ELECTRICAL SOCIETY. Secretary, G. H. Guy, 114 Liberty Street, New York.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Secretary, Ernest H. Davis, Williamsport, Pa. Next meeting, Boston, Mass., May 24, 25 and 26.

NORTHWESTERN ELECTRICAL ASSOCIATION. Secretary, T. R. Mercein, 85 Michigan Street, Milwaukee, Wis.

OHIO STREET RAILWAY ASSOCIATION. Secretary, Chas. Currie, Akron, Ohio.

OHIO ELECTRIC LIGHT ASSOCIATION. Secretary, D. L. Gaskill, Greenville, Ohio.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS. Secretary, C. J. Miller, Canton, O.

SOUTHWESTERN ELECTRICAL ASSOCIATION. Secretary, J. L. Ellis, Oklahoma City, Okla. Next meeting, Dallas, April or May, 1904.

SOUTHWESTERN GAS, ELECTRIC & STREET RAILWAY ASSOCIATION. Secretary, Frank E. Scovill, Austin, Texas.

STREET RAILWAY ACCOUNTANTS' ASSOCIATION OF AMERICA. Secretary, W. B. Brockway, 40 Morris Street, Yonkers, N. Y.

STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK. Secretary, W. W. Cole, Elmira, N. Y. Next meeting, Utica, N. Y., Oct. 11 and 12, 1904.

UNITED ELECTRICAL CONTRACTORS' ASSOCIATION OF NEW YORK STATE. Secretary, F. Fish, Rochester, N. Y.

VERMONT ELECTRICAL ASSOCIATION. Secretary, C. C. Wells, Middlebury, Vt.

General News.

THE TELEPHONE.

MOBILE, ALA.—At the meeting of the Home Telephone Company the following-named officers were elected for the ensuing year: E. Eichold, president; A. S. Lyons, treasurer; Robert L. Douglas, secretary.

OXNARD, CAL.—When the franchise for the Home Telephone Company was refused by the town trustees some time ago, the Sunset Telephone Company made certain promises which are being amply fulfilled. Continuous service has been installed, in place of special hours on Sundays, evenings and holidays. A force of fifteen men has entirely rebuilt the town system, replacing the old iron wire with copper wire, changing the ten-party lines to two and four-party lines, installing two new switchboards, putting in new poles, painting them and placing them wherever possible in the alleys. The toll lines between Oxnard and Montalvo have been rebuilt and men are now at work stringing a line so that Oxnard will be able to call Los Angeles directly.

CARROLLTON, GA.—The Gainsboro Telephone Company, of Carrollton, has purchased the lines of the Commercial Telephone Company at Atlanta and has merged the latter into its own property. This acquisition gives the Gainsboro Company about 400 miles of line, 10 city exchanges and 60 stations, all under the control of the Carrollton exchange.

OBLONG, ILL.—The Oblong Telephone Company has been incorporated with a capital stock of $6000. The names of the incorporators are E. T. Shire, F. P. Willard and Zach Wirt.

LOGANSPORT, IND.—The Home Telephone Company has increased its rate for business telephones from $18 to $30 per year.

FAIRMOUNT, IND.—The Citizens' Telephone Company is installing a new switchboard which will accommodate an additional 100 subscribers.

INDIANAPOLIS, IND.—The Denver County Telephone Company has been incorporated with a capital stock of $3000. The directors are I. L. Eckenberry and others.

ZIONSVILLE, IND.—The Citizens' Telephone Company, of Zionsville, has been incorporated with a capital stock of $15,000. The officers of the company are: President, James O. Hurst; secretary and treasurer, H. F. Gallimore.

INDIANAPOLIS, IND.—Contracts have been made by the Board of Public Safety for telephone service for the Police Department. The new company will furnish 74 telephones and a new switchboard at the headquarters for $1250 and the old (Bell) company will furnish 84 instruments for $1248.

MUNCIE, IND.—The strike of the Electrical Workers' Union of Delaware and Madison Counties Telephone Company, which began last April was formally declared off Jan. 12, a compromise having been effected. It is given out that hereafter none but union electrical workers will be employed by the company.

INDIANAPOLIS, IND.—The Independent telephone people of Indiana are somewhat concerned over the action of Postmaster-General Payne, in ordering the independent telephones removed from the post offics in the Northwest. Should such an order be applied to Indiana it would displace or silence a large number of telephones.

HOLLANDSBURG, IND.—The New Home Telephone Company has been organized by the citizens of this place. An exchange will be established and lines constructed in Wayne and Randolph counties. Connections will be had with towns in Ohio that are connected with the independent companies. Oliver Spencer is secretary of the new company.

SHELBYVILLE, IND.—A new section of switchboard is being put in at the exchange of the Mutual Telephone Company of this city which will increase the capacity to 1100 lines. Another line will be built between this city and Indianapolis as the two lines which are now stretched between the two cities are not sufficient to carry the heavy business of the company.

INDIANAPOLIS, IND.—Judge Anderson, of the United States District Court, has refused the petition of the Cumberland Telephone Company, of Evansville, for a rehearing of its suit against the city to prevent the city authorities from ousting it from the streets for the lack of a franchise to operate therein. The case will now be appealed to the U. S. Court of Appeals.

BROWNSBURG, IND.—At the annual meeting of the Brownsburg Telephone Company J. S. Thorp was elected president; D. R. Marsh, secretary; Alpha Medsker, treasurer, and J. R. Flinn, superintendent of construction. The company is figuring with both the Bell and the Independent Telephone Company relative to getting a direct line to Indianapolis and there is apparently some rivalry between the two companies.

DELPHI, IND.—The Carroll Telephone Company, of this city, and all the co-operative companies throughout the county have effected a consolidation and all the lines are now connected for business. The arrangement is on trial for three months, and if it proves satisfactory a permanent contract will be made. It gives service all over the country, and connects nearly 2000 rural telephones with the local exchange in this city.

ANDERSON, IND.—The December earnings of the Delaware and Madison Counties Telephone Company amounted to $6550 gross; expenses were $2802; interest, $1441; surplus to be applied to stock, $2306. The surplus for December was $2211. The company which operates the Muncie, Anderson, Elwood and Alexandria exchanges is expected soon to reach a dividend basis, although only in operation a year or so. At Alexandria the company is hustling to keep ahead of the Central Union and to that end a new section of board, cable and other equipments to handle 200 or 300 more telephones will be installed.

DES MOINES, IA.—The Mutual Telephone Company contemplates issuing bonds for the extension and improvement of its system.

SLOAN, IA.—The Lawton Telephone Company has been incorporated with a capital stock of $2000. The directors are J. H. Abernathy, R. I. Marshall and others.

OSCEOLA, IA.—The Murray & Lacelle Telephone Company, of Osceola, has been incorporated with a capital stock of $450. The incorporators are George Coon, Jacob Reueder and E. D. Hamm.

STRATFORD, IA.—The Stratford Independent Telephone Company has purchased the system and franchise of the Chamberlain Independent Telephone Company. The name of the new company will probably be changed to Hamilton County Independent Telephone Company. Mr. C. Williams is president.

HOPKINSVILLE, KY.—The Hopkinsville Home Telephone Company has been incorporated with a capital stock of $100,000. R. E. Cooper is president.

BRAINERD, MINN.—It is stated that the Northwestern Telephone Exchange Company will build a line to Walker, Minn., in the spring.

SPRINGFIELD, MINN.—The Citizens' Mutual Telephone Company has been formed here with a capital stock of $25,000. It will build a local and rural system.

HELENA, MONT.—The city council has decided to submit to a vote the proposition of granting a franchise to the Rocky Mountain Bell Telephone Company.

KANSAS CITY, MO.—The Independent Telephone Construction Company, of Kansas City, has been incorporated for the purpose of constructing toll lines of the Home Telephone Company. It is capitalized at $100,000, all paid up. J. S. Brailey, Jr., of Toledo, Ohio, is one of the principal promotors of the enterprise.

HANNIBAL, MO.—An appeal in the case of the Missouri & Kansas Telephone Company, which was fined $150 in the police court on the charge of violating the city ordinances by constructing lines within the city limits without securing the consent of the city council, has been taken to the Hannibal court of common pleas. The case is one in which the city seeks to compel the company to take out a franchise.

LINCOLN, NEB.—The Independent telephone companies of the state have asked the Omaha commercial club to use its influence in getting through the city council of Omaha a franchise for the establishment of an independent telephone exchange in that city, with which all independent companies may connect. The request indicates that a fight will be made on the Bell Telephone people by the independents in Nebraska.

JERSEY CITY, N. J.—The corporation council has drafted a bill providing for the placing underground of telegraph, telephone and other wires. The bill will be introduced in the legislature.

LE ROY, N. Y.—The Canton & Le Roy Telephone Company has been granted a franchise to conduct business in Canton.

LOCKPORT, N. Y.—The Niagara Telephone Company, of Barkers, N. Y., has been absorbed by the Bell Telephone Company, of Buffalo. The independent company had 127 subscribers.

NEW YORK, N. Y.—Sealed bids were received by the police commissioner of the Police Department of the City of New York on Feb. 1 for furnishing and delivering telegraph and telephone supplies.

PRATTSBURGH, N. Y.—The Prattsburgh Overland Telephone Company has filed articles of incorporation at Albany with a capital stock of $10,000. The directors are Estelle Conine, G. T. Conine and L. H. Conine.

UTICA, N. Y.—At the annual meeting of the Utica Home Telephone Company the following-named officers were elected: President, Edgar B. Odell; vice-president, H. F. Miller; treasurer, Edward Bushinger; secretary and manager, C. H. Poole.

BYRON, N. Y.—The Byron Telephone Company has been organized and incorporated to operate a system in Genesee and Orleans counties with an exchange at Byron. The capital stock is $1200. The board of directors is composed of Dr. Prince, A. G. Steele, I. W. White, C. H. Green, H. C. Norton, F. C. Walker and H. C. Warker

ELMIRA, N. Y.—The stockholders of the York State Telephone Company held their first annual meeting a few days ago. Officers were elected as follows: President, W. D. Barnard; vice-president, Edward Davis; secretary and treasurer, Robert M. Dougal. The annual report shows that the increase in the number of telephones during the year was from 2461 to 3617, which is a growth of 50 per cent.

LIBERTY CENTER, OHIO.—The Farmers' Mutual Telephone Company has been organized here. Mr. A. C. Clifton is president. The company has 46 subscribers.

AKRON, OHIO.—The Akron People's Telephone Company directors have elected Will Christy, president; J. S. Benner, secretary; W. F. Laubach, treasurere and general manager.

URBANA, OHIO.—Stockholders of the Urbana Telephone Company re-elected the present officers. The company is planning to make improvements to its exchange.

CHERRYVALE, OHIO.—The Cherryvale Mutual Telephone Company has been incorporated with a capital stock of $350. The directors are J. H. Scofield, O. N. Hamilton and others.

DELPHOS, OHIO.—The Delphos Home Telephone Company has secured a 15-year franchise, being an extension of the old franchise. Having settled this point, the company will now make improvements.

LIMA, OHIO.—The Ideal Construction Company, of this city, will erect a telephone exchange at Hopkinsville for the Hopkinsville Home Telephone Company. R. E. Cooper, of Lima, is president of the company.

CRESTLINE, OHIO.—The Central Union Telephone Company has a franchise ordinance pending in Crestline and hopes to secure the grant, as this is the only town in the district not reached by the Bell Company.

GIRARD, OHIO.—An independent company is being organized here and will ask for a franchise. At present the Bell Company has the field alone and a great many people are dissatisfied because of a recent advance in rates.

PLAIN CITY, OHIO.—The Home Telephone Company, of this place, has been incorporated with a capital stock of $50,000. The company will operate in Franklin, Union and Madison counties. The names of the incorporators are Calvin Liggett, C. W. White, L. H. Elliott, F. N. Mattoon, L. S. Lane and L. Worthington.

NEW LEBANON, OHIO.—V. E. Weaver, of this place, is organizing a mutual telephone company among the farmers of this district. Each member of the company will furnish his own poles and wire. An exchange will be located in South Lebanon. Brooksville, Liberty, Johnsville, Arcanium, Alexandria and Germantown will be connected.

BRYAN, OHIO.—The Bryan Telephone Company has secured control of and absorbed the Williams County Toll Line Company. Nearly $100,000 worth of property changes hands by the deal. O. L. Spangler, formerly auditor for the Williams County Company, has been made general manager of the new company. The other officers remain as heretofore.

INGERSOLL, O. T.—The Union Telephone Company, of Ingersoll, has been incorporated with a capital stock of $10,000 by A. W. Leonard, and M. M. Taylor, of Driftwood; B. F. Blue, E. Bradley and J. B. McGinniss, of Ingersoll.

NEWKIRK, O. T.—A charter has been issued by the secretary of state to the Newkirk Home Telephone Company which has been organized with a capital stock of $5000. The incorporators are J. H. Smock, J. H. Thompson and Guy Stovall.

AMES, O. T.—The Phœnix Telephone Company, of Ames has been incorporated with a capital stock of $10,000 by A. Mathis, B. F. Hogard and W. H. Mathis.

TAMAQUA, PA.—The telephone exchange of the United Telephone Company has been destroyed by fire.

SCRANTON, PA.—The Pennsylvania Telephone Company has expended $200,000 in the general improvement of its service in this city, including the placing of the wires underground. The work is not yet completed. Provision has been made for the installation of a new central energy switchboard with a capacity of 10,000 lines.

READING, PA.—At the annual meeting of the directors of the Consolidated Telephone Company of this city, it was reported that there are now 1800 telephone connections in this city, while contracts for over 400 more have been made. The following-named gentlemen were elected officers: President, Robert E. Wright; vice-president, C. W. Kline; secretary and general manager, S. E. Wayland; treasurer, C. M. W. Keck.

TRIPP, S. D.—The Tripp Telephone Company has been incorporated with a capital stock of $2000.

COLORADO CITY, TEX.—The Texas & Pacific Telephone Company has increased its capital stock from $30,000 to $40,000 and has changed its headquarters from Abilene to this place.

BATSON, TEX.—A telephone system will be established here by the Southwestern Telegraph & Telephone Company. J. E. Farnsworth, of Dallas, Tex., general manager, can give information.

SALT LAKE CITY, UTAH.—The experiments of the Oregon Short Line Railway Company in establishing a telephone system in connection with its telegraph lines has proved an entire success, and many extensions in this direction will be made in the near future.

McDONALDS MILLS, VA.—The North Fork Telephone Company with a capital of $5000 has been incorporated.

ETNA MILLS, VA.—The Richmond & Ayletts Telephone Company has decided to extend its line from Etna Mills to Hanover.

VIRGILINA, VA.—The Virgilina Telephone Company has declared a dividend of 6% and re-elected the present officers. This company operates over 42 miles of wire, connecting at South Boston, Va., with the system there, also with systems in other places.

PORTAGE, WIS.—The Portage Telephone Company has increased its capital from $3000 to $30,000.

MONCLOVA, STATE OF COAHUILA, MEX.—The Monclova Telephone Company will extend its system and make other important improvements.

HERMOSILLO, MEX.—The Mexican Government is extending its system of telegraph wires to all parts of this state. A large amount of material is required for this work of improvement.

ELECTRIC LIGHT AND POWER.

BIRMINGHAM, ALA.—It is proposed to construct an electric light plant in the West End at a cost of between $10,000 and $15,000. P. S. Milner, of the West End, is interested.

STOCKTON, CAL.—R. G. Paddock has applied for an electric light franchise, and bids for same will be received Feb. 19. Eugene D. Graham is county clerk.

WILLIMANTIC, CONN.—At the annual meeting of the Willimantic (Conn.) Gas & Electric Light Company the officers elected were: Directors, J. F. Church, Geo. A. Lewis, Emerson Stone, David F. Tilley and Chas. F. Evans who succeeds his father—the late Edwin Evans; president, J. F. Church; treasurer, George A. Lewis; assistant treasurer, D. F. Tilley; secretary, C. W. Noyes.

ANDERSON, IND.—The Philadelphia Quartz Company, of this city, has abandoned gas, coal and steam for power in its local plant in favor of electricity. It is the first factory in this city to do so.

VINCENNES, IND.—The City Council recently voted down the ordinance relating to the New City Electric Lighting Company, in which Mr. P. K. Tyng is interested. The statement that the ordinance was passed was erroneous.

LOGANSPORT, IND.—The recent flood damaged the local electric light plant to the amount of many thousand dollars. The north wall gave way and tumbled into the river. The plant was compelled to close which left the city in darkness.

TIPTON, IND.—The municipal electric light plant, erected several years ago at a cost of $40,000, is overloaded and the service is not satisfactory. It is planned to enlarge the plant and the old dynamos will be replaced with machines with twice the capacity in order to keep pace with the growing city.

IDAHO FALLS, IDA.—Geo. Chapin, president of the Idaho Power & Transportation Company, writes that it is proposed to construct a plant on Snake River, at a cost of $75,000. No engineer has been selected as yet.

DE WITT, IA.—At the last annual meeting of the stockholders of the De Witt Electric Light & Power Co., it was decided to expend a few thousand dollars in improving, and enlarging the capacity of the plant as the business has outgrown the present facilities. It will be necessary to install some new and larger machinery.

SIOUX CITY, IA.—It is reported that about $24,000 will be expended on improving the city lighting plant.

LIVERMORE FALLS, ME.—The Livermore Falls Water Company and the Livermore Falls Light & Power Company, which are practically one concern, and the Richmond Manufacturing Company, have elected Edwin Riley, president; John H. Maxwell, treasurer and clerk, and Fred E. Riley, engineer.

GREAT BARRINGTON, MASS.—The Great Barrington Electric Company has elected officers as follows: President, Frank Curtiss; vice-president, treasurer and general manager, Parley A. Russell; superintendent, Clyde Parrish.

RAPID RIVER, MICH.—The business men are considering the installation of an electric light plant.

NEGAUNEE, MICH.—The Central Construction Company, of Oshkosh, Wis., has secured the contract for improvements to the electric light plant, for about $15,000.

FLINT, MICH.—Wm. L. Fisher, Superintendent of Water Works, and A. W. Hall, City Engineer, have been requested to report on the cost of installing a municipal electric light plant of about 150 enclosed arc lamps, requiring about 40 miles of wire.

SWANVILLE, MINN.—It is reported that an electric plant will be installed at the milling plant of Koenig Bros. & Meschke.

HANNIBAL, MO.—The citizens voted Jan. 11 to issue $100,000 bonds for rebuilding the electric light and power plant.

BALTIMORE, MD.—At a meeting of the board of directors of the United Electric Light & Power Company, Messrs. A. N. Brady, Samuel A. Beardsley, Nicholas F. Brady and Thomas E. Murray, of New York, were elected directors to represent the new interests who recently purchased a large bulk of the stock of the lighting company.

CONCORD, N. C.—Jas. C. Fink, City Clerk, writes that the matter of constructing an electric light plant is being considered. Dr. W. D. Pemberton is Chairman of the Committee.

WINSTON-SALEM, N. C.—The Board of Aldermen on Jan. 20 awarded to the Fries Mfg. & Power Company the contract for lighting the city for a period of 13 years, beginning March 31, at $60 per light per year.

LEBANON, N. H.—The Lebanon Electric Light & Power Company has elected officers as follows: President, W. S. Carter; vice-president, George S. Rogers; clerk, G. C. Whipple; treasurer, H. M. Day.

CLEMENTON, N. J.—The Clementon Township Electric Light Company has surveyed a route for an extension of its system to Clementon and Overbrook.

JERSEY CITY, N. J.—The Jekyl Island Light & Power Company, of Jersey City, has been incorporated; capital, $50,000. Incorporators: Chas. Lanier, Robt. W. De Forest, and John L. Scrymser.

TRENTON, N. J.—The Columbus Public Service Company, with an authorized capital of $1,500,000, was incorporated at Trenton, N. J., to make and distribute heat, light and power. The incorporators are Horace S. Gould, H. O. Coughlan, of New York, Joseph M. Mitchell, of Newark, B. S. Lantz, of Brooklyn, and Louis B. Dailey, of Jersey City. The location of Columbus is not stated in the dispatches.

IRVINGTON, N. J.—The Council on Jan. 5 opened bids as follows for lighting the town: United Electric Company, for 430 lights of 30-cp each, for a period of five years, $15 per lamp; on a three-year contract, $15.50, and for one year, $16. Wm. L. Glorieux, of Irvington, offered to purchase necessary generators and furnish the current from his smelting works at Enterprise Hill at $9 per lamp per year.

OWEGO, N. Y.—The stockholders of the Owego Light & Power Company have elected W. S. Truman, president; Hon. W. G. Phelps, vice-president, and G. F. Andrews, secretary and treasurer.

POUGHKEEPSIE, N. Y.—Officers of the Poughkeepsie Light, Heat & Power Company have been elected as follows: F. R. Bain, president; T. R. Beal, secretary; William Shickle, treasurer.

NEWBURGH, N. Y.—At the annual meeting of the Newburgh Electric Light, Heat & Power Company, officers were elected as follows: Wm. R. Beal, president and general manager; T. R. Beal, secretary and treasurer.

OGDENSBURG, N. Y.—The town of Waddington, at a special election a few days ago, voted to sell its municipal electric light plant and water power and rights to a Canadian company for $3750, the amount which now remains unpaid on the plant. It is stated that the municipal operation of the plant did not prove satisfactory.

ATHENS, OHIO.—The new municipal lighting plant is being erected and a number of manufacturing establishments are contracting for power.

SIDNEY, OHIO.—The Sidney Electric Light Company will install two new engines; an incandescent machine and will make other improvements to its system.

COLUMBUS, OHIO.—The recent floods and high water caused serious damage to electric lighting plants in a number of Ohio cities. Lighting plants at Columbus, Toledo, Youngstown, Grand Rapids and other towns were out of service, leaving portions of the towns in darkness.

MECHANICSBURG, OHIO.—T. J. Long has closed a contract with the village council to install a lighting plant and furnish light for the town as well as for private service. He agreed to supply 30 arc lights at $66 each, and $60 for each additional lamp. The plant is to be completed by May 1, 1904. Work will start as soon as the weather permits.

NEW FREEDOM, PA.—Bids will soon be asked for water works and an electric light plant.

HARRISBURG, PA.—Bids will be received Feb. 19 for installing electric light and power in the county jail.

MARIETTA, PA.—The directors of the Elizabethtown & Marietta Light Company have decided to enlarge the plant.

BEAVER, PA.—Wm. H. Iron and Eugene S. Hoopes are on the committee to solicit subscriptions of an electric light plant, which is to be purchased by the borough.

HARRISBURG, PA.—The Southampton Light, Heat & Power Company, of Southampton township, Franklin County, has been incorporated with a capital stock of $5000.

HARRISBURG, PA.—The Middlespring Light, Heat & Power Company, of Southampton township, Cumberland County, has been incorporated with a capital stock of $5000.

READING, PA.—The mayor has vetoed the ordinance enabling the city to borrow $200,000 to establish a municipal electric light plant. The veto was sustained by the select council.

PROVIDENCE, R. I.—The Narragansett Lighting Company held its annual meeting last week in the office of the president when the following gentlemen were elected for the coming year: President and general manager, Marsden J. Perry; vice-president, Arthur H. Watson; assistant general manager, Arthur B. Lisle; treasurer and secretary, Edward A. Barrows. Mr. T. A. Pierce, who formerly held the office of treasurer and secretary, stated that the increasing business in the company required more time than he could give to it and he desired to be relieved of further responsibility after a continuous service of 18 years.

NASHVILLE, TENN.—Mr. J. W. Pentecost, superintendent of the city electric light plant, has submitted to the Board of Public Works his annual report for the year 1903. Two additional boilers have been installed during the year, increasing the boiler equipment of the plant by 200 horse-power and more than 70 miles of live wires have been put out. From 510 on Jan. 1 the arc lights were increased to 642 at the end of the year. There were 392 incandescent lamps put in during the year. The expense of operating amounted to $27,293.37. Twelve thousand dollars was paid in interest and into the sinking fund on account of light bonds. This $12,000 added to the cost of operation, makes $39,293.37. The wages and salaries of the employes amounted to $15,142.27. The amount expended for coal was $7,015.99. At the end of the year there were 1,839 incandescent lamps in service. The output for the year amounted to 1,433,014 kw-hours. Construction work during the year cost $39,822.17. Of this amount $14,000 was expended for boilers; $7,653 for engines and generators; $5,712.30 for wiring; $5,099.75 for labor; $1,797.43 for stationary equipment; $1,824 for poles, etc.; $1,579.93 for foundations. If all the construction were considered as repairs and renewals, the cost per kw-hour would figure out at about 6 cents per kw-hour, a very high rate of production and supply chiefly for arc lighting with overhead wires. Rate of depreciation is not stated, nor is distinction made between new investment and ordinary upkeep.

HILLSBORO, TEX.—E. D. Kelley, superintendent of the Hillsboro Gas & Electric Company, writes that it is proposed to purchase a 200-hp boiler.

CLEBURNE, TEX.—The Cleburne Gas & Electric Light Company, has been organized with a capital of $150,000, by J. F. Strickland, of Waxahachie; R. Vickery, of Ft. Worth, and others.

CLEBURNE, TEX.—The Cleburne Gas & Electric Light Company has been organized here with a capital stock of $150,000 by R. B. Sticher, J. F. Strickland, Osce Goodwin and M. B. Templeton, all of Waxahachie, and R. Vickery, of Fort Worth.

BALLINGER, TEX.—The Ballinger Light & Ice Company has been organized here for the purpose of constructing and operating an electric light and power plant. It has a capital stock of $10,000. The incorporators are W. A. Norman, R. B. Creasey, E. J. Hardgrave and Lewis Alexander.

DEL RIO, TEX.—J. W. Maxey, an engineer of Houston, is preparing plans for a large electric power plant which is to be established at San Felipe Springs, adjacent to this place. It is proposed to generate 375 horse-power by means of the flow of water from the springs. The electrical energy will be conducted to the town where it will be used for lighting and power purposes. It will also be transmitted to irrigation and manufacturing plants in this section. G. Bedell Moore, of San Antonio, who owns the San Felipe Springs, is back of the project.

PRAIRIE DU CHIEN, WIS.—The electric light plant at McGregor was totally destroyed by fire a few days ago, the loss being about $11,000.

BLACK RIVER FALLS, WIS.—The citizens have voted to issue $25,000 bonds to purchase the Owens water power to run the electric light plant.

LAMARTINE, WIS.—The Lamartine Peat, Light & Power Company has been organized with a capital of $150,000 by Dr. C. A. Beebe, C. J. Medberry, F. J. Rueping and others, to develop peat marshes in Lamartine. Application has been made for a franchise to furnish light and power.

THE ELECTRIC RAILWAY.

VENICE, ILL.—The management of the Granite City & Venice Electric Railway Company is preparing plans for a new power house and car houses at Venice.

CRAWFORDSVILLE, IND.—The Consolidated Traction Company is arranging to build a large power house in Crawfordsville in the spring. Edward Hawkins is president.

WABASH, IND.—The stockholders of the Wabash & Rochester Railway Company, organized to build a line from this city to Rochester, 35 miles, have elected the following officers: Charles Crane, president; P. E. Wilcox, vice-president; E. S. Pratt, secretary, and C. E. Barnum, treasurer.

BEDFORD, IND.—The City Council has granted an electric street railway franchise to a company of local men, including Col. A. C. Voris, W. M. Mathews, J. W. Gouser, M. N. Messiek, E. B. Thornton, V. V. Williams, I. N. Glover and Frank Owens. The company will incorporate at once.

VINCENNES, IND.—The Western Indiana Traction Company has elected officers, as follows: Samuel Williams, of Vincennes, president; F. S. Robinson, of Cloverland, vice-president; John Le Croix, of Vincennes, secretary-treasurer. The company will build a line from this city to Terre Haute this spring.

WOLFSVILLE, MD.—The Catoctin Railway Comapny has been formed here to operate an electric railway. The officers are John H. Maugans, president; W. B. Stottlemyer, vice-president, and H. M. Warrenfeltz, secretary.

ESCANABA, MICH.—The Escanaba Electric Street Railway Company is to extend its line and make improvements to the power house.

BENTON HARBOR, MICH.—The Kalamazoo & Lake Michigan Electric Railway Company will soon begin the construction of its proposed line between Kalamazoo, Benton Harbor and South Haven, Mich. In all, 66 miles of track will be built. Estimates for building and equipping the line are now being received. The engineers are the Western Engineering & Construction Company.

MINNEAPOLIS, MINN.—The Minneapolis method of curing the spitting evil is to have the conductor hand the offender a red card, with the city ordinance about spitting printed on it.

CROOKSTON, MINN.—An electric railway throughout the Red River valley is planned by J. P. Booker and other capitalists of Crookston. Eastern capitalists have agreed to put $100,000 into the enterprise if local capital can raise an additional $100,000.

OMAHA, NEB.—The Omaha & Council Bluffs Street Railway Company announces that the new 6000-hp generator station will be completed at a cost of $500,000. The line between South Omaha and Omaha will be extended to Fort Crook, 5 miles from the present terminus. The Sherman Avenue line, the West Leavenworth Street and Walnut Hill lines will be rebuilt.

UTICA, N. Y.—It is stated that an extensive system of electric railways will be constructed in the North Woods next summer. The first step in the projected enterprise will be the building of a line connecting upper St. Regis Lake and Lake Clear with Paul Smith's. Power for the proposed road will be taken from Franklin Falls in the Saranac River, 20 miles away.

WILLIAMSBURG, N. Y.—A railroad company known as the Eastern Traction Company of Waterbury, Conn., has had representatives in Williamsburg for several weeks, getting the consents of property owners on Roebling Street, from the plaza of the new Williamsburg Bridge, for an electric road through Greenpoint into Long Island City, connecting at Astoria with the new Blackwell's Island Bridge. The promoters of the movement, in addition to obtaining consents, are giving an opportunity to property holders of becoming stockholders in the railroad company. It is stated that many consents had already been obtained, and that the company is capitalized at $5,000,000.

BROOKLYN, N. Y.—The American Realty Traffic Association of Brooklyn has been incorporated at Albany, with a capital of $1,000,000, to conduct railway construction business and to enter into contract with railway companies for the transportation of personal property of every description. The directors are John L. Wells, Lewis B. Grant, Ashley T. Cole, William J. Bagnall and Charles T. Lark. President Winter, of the Brooklyn Rapid Transit, explains that the corporation is a small private concern to operate as a branch of the Brooklyn Rapid Transit system. Its organization was the result of the Brooklyn Rapid Transit taking over the ash collecting contracts held by Milton H. Kennedy some time ago. It was deemed advisable to have a corporation organized to do this work.

FELICITY, OHIO.—The Felicity & Bethel Railroad Company, capital stock $50,000, has been incorporated by Frank Scott. S. F. Kennedy, J. W. Hayden, J. C. Gunnings and W. A. Gregg, of Felicity.

ZANESVILLE, OHIO.—A movement is said to be on foot whereby Tucker, Anthony & Company, of Boston, will obtain control of the property of the Zanesville Railway, Light & Power Company. The Columbus, Newark & Zanesville Railway, which is owned by the Boston people, will soon be completed into Zanesville, and the local system could be consolidated with the interurban line to considerable advantage.

UNION, ORE.—A franchise to extend an electric railway system from this city to Hot Lake, Cove and other nearby cities will be asked for in the near future by T. H. Crawford. The estimated cost of the contemplated extension is $60,000.

CHESTER, PA.—The merger of the Wilmington & New Castle Electric Railway Company and the New Castle & Delaware City Railway Company into the Wilmington, New Castle & Southern Railway Company will soon be effected and a charter applied for. It is reported that the new company and the Middletown & Odessa Railway Company are negotiating for the construction of a line from Delaware City to Odessa, connecting the two lines.

PROVIDENCE, R. I.—It is intended to amend the charter of the Valley Falls & Franklin Street Railway Company, by giving the company authority to furnish and sell electricity for lighting, heating and power.

SALT LAKE CITY, UTAH.—A contract which involves the uniting of Salt Lake and Ogden by an electric railway system has been signed by Simon Bamberger, of this city, and J. J. Burns. At Farmington, a power plant will be established at an estimated cost of $115,000. By the terms of the contract the capital stock of Mr. Bamberger's road which runs as far as Farmington will be increased from $800,000 to $1,000,000 and bonds to the amount of $1,000,000 will be issued and sold, although Burns and Bamberger will retain control.

BARABOO, WIS.—William J. Bell, for many years manager of the Baraboo Telephone Company, is endeavoring to interest the business men of Portage in building an electric railway from that city to Grand Rapids. He is backed by Chicago capitalists.

TORONTO, ONT.—At the annual meeting of the Toronto Street Railway Company, held Jan. 20, reports of directors stated that gross earnings for the year as $2,172,089, an increase of $337,179 over the gross earnings of the previous year. The company's net earnings were $971,264, an increase of 18.5 per cent. Out of the net profits there have been declared four quarterly dividends, amounting to $326,548. After deducting permanent charges paid to city, and having transferred $50,000 to contingent accounts, there remains a surplus of $180,628. There has been expended for the general purposes of the company and charged to capital account, $379,615. The present officers and directors were re-elected, with the exception of James Ross, Montreal, resigned, who is succeeded by J. C. Grace.

NEW INDUSTRIAL COMPANIES.

THE W. & B. ELECTRIC SAND-BOX COMPANY, of Philadelphia, has been incorporated in Delaware to manufacture the Whiting & Bacon electric sand-box. The capital stock is $75,000.

THE INTERNATIONAL POWER COMPANY has been incorporated in the District of Columbia, with a capital stock of $5,000,000, by A. A. Connally, R. S. Donaldson and E. W. McCormick.

THE ELECTRIC BATTERY COMPOUND COMPANY, of St. Louis, Mo., has filed articles of incorporation. The capital stock, full paid, is $100,000, and the stockholders are G. W. Greener and Frank M. Holmes, Geo. W. Holmes, Wm. Conway, R. W. Hebard and R. H. Stevens.

THE BINNIE ELECTRIC DRILL & MACHINERY COMPANY, of Fairfield township, Westmoreland County, Pa., has been chartered with a capital stock of $10,000. Among the directors are Robert Binnie, sr., and Robert Binnie, jr.

THE SHANAHAN TROLLEY SPECIALTY COMPANY, of Little Falls, N. Y., has been incorporated with a capital of $50,000. The directors are T. B. Shanahan and J. N. Shanahan, of Gloversville, and H. P. Snyder, of Little Falls.

THE PIEDMONT CONSTRUCTION COMPANY, Indianapolis, Ind., has incorporated for the purpose of promoting, financing, constructing, equipping and operating street and interurban railways and electric plants. The capital stock is $75,000. The principal office will be in Indianapolis. Joseph Little, Jas. F. Wilson and G. E. Coghlin are the incorporators.

THE WELLS MANUFACTURING & SUPPLY COMPANY, of Indianapolis, Ind., has incorporated with a capital stock of $25,000. The company will manufacture supplies for steam and electric railways, electric lighting, telephone and telegraph companies and for contractors and builders. A. H. Wells, B. W. Forkner and E. G. Storms are directors.

THE OVERLAND & MARINE TELEGRAPH COMPANY of New York City has been incorporated to conduct a business of wireless telegraphy, and to manufacture telegraph apparatus. The capital stock is $100,000, and the directors are John W. Chapman, W. R. Sainsbury, H. R. Dennis, J. Norris Miller, Jesse W. Tobey and Harry J. Peel, of New York City.

LEGAL.

CONSOLIDATION IN ST. LOUIS.—The Union Electric Light & Power and Motor Edison Company's motion before Judge Ryan, in St. Louis, to strike out the amended petition in the case of Ruf, which held that the consolidation was contrary to law, has been decided in favor of the plaintiff. The decision is considered of great importance.

NEW YORK PIPE GALLERIES.—The New York Supreme Court, Justice Fitzgerald, has issued an injunction, upon application of J. Rhinelander Dillon, restraining the President of the Borough of Manhattan from opening bids, or taking any steps toward making a contract for the construction of pipe galleries to carry gas and water pipes and telegraphs, telephone and electric wires in the rapid transit subway in Broadway, between Fulton and Morris Streets. Justice Fitzgerald holds that the Commissioner of Water Supply, Gas and Electricity has control of these matters.

TELEPHONE LINES AND ELECTRIC RAILWAYS.—Judge Artman, of the Boone County Circuit Court at Lebanon, Ind., has just rendered a decision in a case involving the superior rights of telephone and electric railway companies. The New Long Distance Telephone Company, of Indianapolis, complained of Townsend Reed & Co., builders of the Northwestern Traction line, and asked that the latter be enjoined from interfering with its wires. Judge Artman denied the writ and held that when a traction company has to string its trolley wires in a certain way, telephone companies are required to change their wires to conform thereto. A telephone company cannot enjoin a traction company from thus interfering with its wires, but may recover from the traction company by a suit at law, the expense incurred by the enforced change

of wires to conform to those of the electric line. This is the first ruling in the state on the direct question. Similar suits have been brought but were compromised before reaching trial.

THE EVANSVILLE, IND., TELEPHONE LITIGATION.—The litigation between the Cumberland Telephone Company and the City of Evansville has raised a question of great interest and much concern. The decision of the United States Court is that the Evansville Telephone Exchange has no right to transfer its franchise to the Cumberland Telephone Company without a specific provision for such transfer, although the franchise was granted the Evansville Telephone Exchange, its successors and assigns, and contains no provision that prohibited the transfer. The court holds that there is nothing valid in the claims of the company and no reason why the city should not remove its poles and wires. The company, however, has filed an appeal bond and contends that the higher courts will not fail to take an entirely different view. A large number of public utility corporations are doing business under purchased rights and it is a question of much concern whether the law protects them in case of transfer without specific authority.

TELEPHONE RENTALS.—The Indiana Supreme Court has affirmed the lower court decision refusing Arthur B. Irvin the statutory penalties he demanded from the Rushville Co-operative Telephone Company for its refusal to connect him with other subscribers, while his telephone bill was unpaid. Irvin, who is a lawyer, refused to pay on the ground that the company owed him a sum of money in excess of the bill on a claim assigned to him by one of his clients who had worked for the company. He claimed a set off and also that he was discriminated against, contrary to the statute. It was shown that thirty-five other subscribers were also behind in their rents, but were being served at the time Irvin was disconnected. The court held that his positive refusal to pay except by setting off the bill for labor against the unpaid rent justified the company in its treatment of him. The company was not bound to take unpaid labor claims in satisfaction of telephone rentals. Irvin had a right to sue on his claim but could not force a set off in an action for statutory penalties. Irvin sued for ten penalties of $100 each for ten refusals to connect his telephone.

TROLLEY TRANSFERS.—The New York State Court of Appeals has dismissed the appeal of James S. Lehmaier from a decision of the lower courts denying him a mandamus to compel the Interurban Street Railway Company of New York to give free transfers at Eighth Avenue and One Hundred and Twenty-fifth Street. Justice O'Brien, writing the opinion, declares that this is not the proper remedy, and suggests that the statute provides a penalty of $50 in favor of any individual who has been refused a transfer where one should legally be issued, and that in addition he may institute an action for damages to which he may have been subjected in consequence. In addition, Justice O'Brien says, the Attorney General is authorized to bring action to vacate the charter of any railroad company that violates the law, and a refusal to give transfers in certain cases would doubtless bring a corporation within the scope of that statute. Provision is also made, it is added, by the law for the investigation by the Railroad Commissioners of complaints of neglect of duty by railroad corporations, and their recommendation is enforceable by mandamus. A mandamus, it is held, is not the proper remedy until after action by the Commissioners.

POWER SUIT FOR $300,000.—Alleging that the Toluca Light & Power Company of Toluca, Mexico, has fraudulently misappropriated $80,000 in money and securities, which are the rightful property of Alexander Potter and William Tuteur, mining engineers of New York City, Mr. Potter and Mr. Tuteur have begun suit in the New York City Supreme Court here for the recovery of that amount. It is charged that the company has violated its agreement to transfer $50,000 in securities and $30,000 in money to the engineers as a return for their obtaining for the company certain large contracts in and near Toluca, a city of about 12,000 population, situated about 50 miles west of the City of Mexico. The Toluca Electric Light & Power Company was organized by Clinton L. Rossiter, formerly President of the Brooklyn Rapid Transit Company, last Spring. Mr. Rossiter had visited Mexico and obtained valuable concessions from the Government for the enterprise, and when he returned to New York he incorporated the company under the laws of this State. J. Aspinwall Hodge is counsel for Mr. Potter, who has an office at 143 Liberty Street, this city. Mr. Tuteur is in Mexico at the present time. Issues have been joined in the suit, and it is expected that it will be placed on the calendar within a month.

PASSENGERS FEET BURNED.—In a recent New York decision, it has been held by the Third Appellate Division, in the case of Mary Powell against the Hudson Valley Railway Company, that evidence that, owing to the overcrowded condition of a street car, the plate above one of the wheels of the car was pressed down upon such wheel, and that the resulting friction heated the plate to such an extent that a passenger who was standing thereon, there being no vacant seats, had her shoes and her feet and her dress burned, is sufficient to raise a presumption that the street railway company did not perform the duty incumbent upon it of using the utmost diligence and care for the protection of its passengers. In answer to questions by the defendant's counsel, an expert for the injured passenger admitted that the injuries to her nervous system were due wholly to shock caused by the burning, and not to the physical burn inself. It was therefore asserted that no physical injury was connected with the plaintiff's nervous condition. Justice Smith, for the court, said that while the Court of Appeals has held that no recovery can be had for injuries sustained by fright occasioned by the negligence of another, where there is no immediate personal injury, our courts have never gone so far as to hold that where there is a physical injury for which a party is legally responsible that that party is not responsible for any damages which follow from the shock or fright incident thereto.

TROLLEYS VS. STEAM.—The encroachments of parallel electric roads upon the steam roads, and the determination of the latter to conserve their interests in this respect, are reflected in two cases now on argument in the Appellate Division at Albany, N. Y. One is that of the people ex rel. New York Central and Hudson River Railroad Co. vs. the State Railroad Commissioners and the Rochester, Syracuse and Eastern Railroad Co., the other that of the people ex rel. New York Central and Hudson River Railroad Co. vs. the State Railroad Commissioners and the Monroe County Electric Belt Line Co. In the first case the relator seeks to review by writ of certiorari the determination of the Railroad Commissioners that public convenience and a necessity require the construction and operation of an electric railroad between Syracuse and Rochester. The Commissioners granted a certificate on Aug. 28, 1902. The New York Central claims that there is no necessity for such a road, and that the Central now serves all of the villages in the applicant's territory. In the second case the proceeding is similar. The electric road proposes to build an electric railway commencing at the eastern limit of the city and running thence to Pittsford, Fairport, Despatch, and back to the eastern limit of Rochester, a distance of twenty miles. The Central makes the same claim in this case, that public convenience does not require such a belt line, and that the territory is now served, not only by the Central, but by two trolley lines now in operation.

PERSONAL.

E. O. SESSIONS.

MR. E. O. SESSIONS has been appointed engineer of the western sales office of the Stanley Electric Mfg. Company, with headquarters at Chicago. He has just completed the installation of three 3500-kw generators for the New York Edison Company. During the past summer, Mr. Sessions was actively engaged on the engineering work connected with the installation of Stanley sub-stations of the Cleveland and Southwestern Traction Company. A Kentuckian by birth, Mr. Sessions received his education in the public and high schools of Louisville, and by private instruction at Boston. This was further supplemented by post-graduate work at the Ecole de Polytechnique at Paris and, from a practical standpoint, in the testing laboratories of the old Thomson-Houston Company at Lynn, Mass. This was an excellent preparation for the important work of which he has had charge in the last few years. His quick perception, aggressive spirit and pleasing personality combined with his engineering knowledge and executive ability have stood him in good stead under many trying conditions. Mr. Sessions' electrical career began in 1888 in the early days of the electrical industry. His professional career includes his connection with the old Thomson-Houston Company, as already noted; the superintendency of the electrical properties of Mr. Frank Jones, the capitalist of New England, with whom he was connected for four years; engineer for the General Electric Company and later for the Stanley Electric Mfg. Company. It will be recalled that he was resident engineer for the latter at Sault Ste. Marie, Mich., in connection with the installation of the immense power plant of the Michigan Lake Superior Power Company. He has also acted as consulting engineer for Mr. W. S. Stratton, the well-known Cripple Creek magnate, in connection with the design of the power plant and betterments of the street railway system at Colorado Springs, Colo. In fact, Mr. Sessions has installed plants in all quarters of the globe. These have included in both the railway, lighting and power field, not only steam power plants, but turbo-electrical installations as well, the latter including the second largest one in the world. He has given considerable attention to high tension work, having installed several of the most important high tension transmissions. Mr. Sessions furthermore has frequently been called in to present reports on the physical and financial condition of properties.

MR. HORACE F. HARDY has succeeded Mr. John H. Glade as secretary of the South Side Elevated Railroad of Chicago.

REAR-ADMIRAL MELVILLE, U. S. N., has sailed for Europe to study steam turbine machinery, particularly for use in the new 4000-ton scout ships of the navy.

MR. ARTHUR WARREN, who created and organized the Westinghouse Companies' Publishing Department, and has managed it from the beginning, resigned his position on Feb. 1.

MR. CARL HERRING has recently been elected president of the Engineers' Club of Philadelphia. That important organization will find him an executive of great force and ability, as proved by his record as president of the American Institute of Electrical Engineers.

MR. FRANK C. PERKINS has carried on for six years a school for teaching electricity at Buffalo, N. Y., known as the Cataract Electrical School, and has lately developed its field considerably.

MR. GEORGE H. WATSON has resigned the presidency of the Northern Engineering Company, incorporated. Prior to associating himself with that concern he was connected with H. B. Coho & Company. His present location is Paterson, N. J.

MR. F. PEARSON, vice-president and consulting engineer of the Mexican Light & Power Company, Limited, has left New York for the Southern Republic, in order to inspect the progress made in the construction of the company's extensive power transmission system.

MR. FRED D. SAMPSON, manager and engineer of the Charlotte Electric Railway, Light & Power Company, of Charlotte, N. C., has resigned and is now associated with the D. A. Tompkins Company, engineers, of Charlotte, N. C., in the capacity of electrical engineer.

MR. P. SANDOVAL, of P. Sandoval & Company, of Nogales, State of Sonora, Mexico, is now in New York. The Sandoval people are largely interested in mines in Sonora. Mr. Sandoval is expected to place some fair sized contracts for electrical mining equipment while here. He is a guest at the Fifth Avenue Hotel.

NORMAN G. KENAN.

MR. NORMAN G. KENAN, who was recently elected president of the Cincinnati Gas & Electric Company, is a man of most interesting career and personality, and may be said to have been connected with illuminating interests from the very beginning. He was born in Boston, Mass., December 28, 1849, and at the age of eight went with his parents to Cloverport, Ky., where his father engaged in the manufacture of oil from cannel coal. A little later the senior Kenan moved to Cincinnati and became connected as engineer with the Gas Company, dying of cholera in 1866. This sad event left the family without resources, but young Norman immediately proceeded to provide for his mother and her five other children by selling cigars in a restaurant. This he soon abandoned to become a conductor on one of the street car lines. Every spare moment of his time, however, was given to study and to night school, while his courtesy and steadiness attracted the attention of many of the passengers on his car. One of these was President Miller of the Gas Company, through whom he was given the position of time-keeper at the West End works with which his father had once been connected. He was rapidly promoted and in 1873 became chief clerk of both the West and East End works. During all this time he was studying gas manufacture with the object of becoming an expert, and so impressed the management of the company with his abilities that in 1884 he was made superintendent of the West End works. In 1887 he became general superintendent of all the works and three years later was appointed assistant to the president, at which time he had supervision of the construction of the first electric light plant erected by the old Gas Company. In 1892 Mr. Kenan was elected vice-president of the company and has now risen by sheer merit and force of character to the head of the concern, which is one of the largest gas and electric lighting systems in the whole country. Under Mr. Kenan's management the business of the company has increased far beyond the expectations of the directors, and the confidence of his associates in him is shown in the fact that when elected to the presidency he was given power to select his own successor as vice-president.

MR. WILLIAM CURRIE has resigned his position as engineer of the Chicago office of the Stanley Electric Mfg. Co. to look after his private interests at Montreal. Mr. Currie for many years was assistant to Mr. C. C. Chesney. His many friends will regret to hear of his leaving the electrical field to engage in private business.

MR. J. ALLEN HEANY, of York, Pa., to whose novel asbestos insulated wires we have lately drawn attention, wrote recently a strong letter to the newspapers on the Chicago theatre fire and in favor of better insulation, comparing with concrete and steel in the safety given to buildings against sudden and disastrous conflagration.

MESSRS. OTTO BLATHY, Max Dery and Prof. Charles Zipernowsky have been elected "members of honor" of the Hungarian Electrical Society of Buda Pest, in token of their distinguished services to electricity. The certificates of election were handed to them by a deputation of ten members. The honor followed the reading of a paper by Mr. Alex. Wolf on "A Chapter in the History of Electrotechnics in Hungary."

MR. H. S. WAITE, general manager of the Case Mfg. Company, of Columbus, Ohio, is now on a visit to New York. He reports that business is flourishing in his section and that the Case plant has sufficient orders in hand to keep it busily engaged for the next four or five months. Mr. Waite is making his headquarters at the local offices of the Case Company in the Singer Building. He expects to leave about the middle of next week.

DR. JULIO VINGUECHERE, a South American scientist and mining expert, has been in Schenectady to inspect some recent electrical machinery and appliances to be used in the government mines of Peru. The doctor has spent many years in the development of mines in the Cordilleras of the Andes and believes that the use of electrical machinery is the only true solution of the development of the wealth in the mines now unworked because of the cost of operation.

MR. EUGENIO DAVERI, for some ten years manager of the construction department of the Italian Edison Company, of Milan, has resigned and has taken up the agency of foreign manufacturers as selling representative. He will be glad to hear from American manufacturers of trolley cars, and electrical apparatus in general. He can be addressed care of the Societa Edison, 6. Via Lecco, Milan, Italy.

MR. CHARLES FENWICK, of Fenwick Freres & Company, of Paris, one of the largest handlers of American machine tools, etc., in Continental Europe, has sailed for the other side, after a brief sojourn in the States. He left behind him some fair-sized orders with the Brown & Sharpe Mfg. Company and with the Pratt & Whitney branch of the Niles-Bement-Pond Company, 136 Liberty Street, New York.

MR. C. G. Y. KING, M. E., member of the engineering staff of the Chicago Edison Company, is to lecture before the General Electric Agents, etc., in New York City, on February 17, on the "Erection of a 5000-k.w. Steam Turbine," with some 70 slides by way of illustration. Mr. King is a veteran and accomplished central station man.

MR. CHARLES J. GLIDDEN, the well-known telephonist and now equally widely known in the automobile field, lectured last week before the Automobile Club of America, on "Thirteen Thousand Nine Hundred and Seventy-five Miles Automobile Drive in Fifteen European Countries and Across the Arctic Circle." It was a great lecture, profusely illustrated by lantern slides. Mr. Glidden has kindly consented to repeat it for charitable purposes in New England and elsewhere.

MR. WILLIAM MACKENZIE, for several years traffic manager of the Mexican Gulf Railway and who is now interested in some water powers located in the vicinity of Mexico City, is now in New York for the purpose of making financial arrangements which will permit of the construction of an hydraulic plant capable of developing about 7000 horse-power and situated about 50 miles from the Mexican capital. He is at the Hotel Imperial and at Room 1406 Broad Exchange Building.

MR. OSCAR T. CROSBY, the electrical engineer and explorer, has returned to Paris from a trip to Central Asia, where he explored almost inaccessible parts of Turkestan and Thibet. On his way to Thibet Mr. Crosby skirted Afghanistan, visited Chinese Turkestan, and later, traversed Kashmir and the Karakorum caravan route, probably one of the most difficult used by human beings to India. It will be remembered that Mr. Crosby in 1900 explored by way of Abyssinia unknown regions of the upper Nile. He is expected in New York toward the end of this month.

MR. WALTER W. WHEATLY, general manager of the Street Railway Department of the Public Service Corporation and of the street railway companies controlled by that corporation in New Jersey has resigned, and resulting changes in the management have been announced by Thomas N. McCarter, president of the corporation. The resignation has been accepted, and took effect Feb. 1. The practical operation of the system hereafter will be under the personal direction of Albert H. Stanley as general superintendent. He has just come from Detroit, where he held a similar position. Mr. Wheatly has been doing splendid work, but the public needed a scapegoat, on account of its impatience over the necessarily slow welding together of the unrelated parts of the system. And then the record winter intensified the situation.

THE ENGINEERS' CLUB at its recent annual meeting gave marked recognition to the growing strength of electrical men in the club, already one of the foremost in New York City. Mr. J. C. Chamberlain, a well-known electrical engineer, was elected a trustee and made also chairman of the House Committee. Mr. M. G. Starrett, of the Interurban and Metropolitan Street Railway Companies, was elected a trustee to serve until 1907. Mr. T. C. Martin, already member of the board, was made second vice-president and put on the membership committee. The club's new president is Mr. W. H. Fletcher, a man of strong personality and qualities of leadership. The financial condition of the club is very sound and with a waiting list of nearly 200, many of whom have been up for over a year, there was a unanimous vote for the constitutional amendment raising the limit from 1,000 to 1,200.

MR. C. E. BROWN has resigned his position as electrical engineer for the Canadian General Electric Co., having been appointed by the Canadian Government as electrical engineer of the commission recently established to investigate the electro-thermic processes of manufacturing iron and steel in Europe. All who know Mr. Brown, and know of his work, feel that the Dominion Government is exceptionally fortunate in being represented by so thorough and practical a man. Mr. Brown is a native of Iowa and was graduated with honors from the University of that State. He later took up post-graduate work at Cornell University. After that he became connected with the General Electric Co., with which he was connected for four years as electrical engineer. Electrical manufacturing then took on great strides in Canada, and Mr. Brown went to Peterboro, Ontario, where he has been associated with the Canadian General Electric Co. for the last five years.

DR. J. L. BORSCH, of Philadelphia, has testified in a recent trolley personal damage suit that he has restored a man's sight by means of radium after every other means had failed. That the man has his sight again is a fact, as he was in the court room with apparently good vision and a prominent physician, who after treating him himself referred him to Dr. Borsch, testified to the man's condition before being treated by the radium expert. Dr. Borsch says: "In Sharpe's case, there were still remaining some normal cells—the man was not entirely blind, as stated—and these I stimulated into greater activity by use of the radium. Gradually I noticed a change in the man's condition and found that the stimulation had resulted in producing an amount of activity in the remaining cells not affected, equal or very near, at least, to the combined activity of good and bad before the injury. I applied this little twisted glass affair to the eye for about five minutes at a time, bandaging it very tightly. The radium used was not in excess of 20,000 activity."

PROF. W. S. GOLDSBOROUGH, of the Department of Electricity at the St. Louis Exposition, gave the New York Electrical Society last week a most admirable lecture on electricity at modern expositions and at the Louisiana Purchase Exposition in particular. The lecture was profusely accompanied by lantern slides, and to these the discourse was adjusted, the completeness of the series being shown by the fact that over 100 were thrown on the screen. Prof. Goldsborough brought out very clearly the fact that electricity lighting had made possible the modern world's fair with its large night attendance and its spectacular effects. At the same time, he showed that of later years the electric motor had effected changes in the daylight plan and had contributed largely to the increase in the number of "live" operating exhibits. Prof. Goldsborough, in passing, took occasion to pay a tribute to the memory of the late Luther Stieringer as a pioneer in exposition lighting. He touched also upon the subject of international electrical congresses, and in allusion to the work now being done under Prof. Elihu Thomson, an excellent portrait of whom he showed, said he believed that the St. Louis Congress would be one of the most important in the series. President Carty, in closing the meeting, suggested happily that President Loubet of France ought to be invited to open by cable the Exposition, and after a felicitous speech by Mr. C. O. Mailloux, the society voted its hearty approval of the idea.

EDUCATIONAL.

DRAFTING.—The General Electric Company has established a Drafting Room Apprenticeship Course, to which young men who are able to pass a satisfactory examination in arithmetic are eligible. The course is intended to fit applicants for drafting room positions. Further information can be obtained by application to Mr. J. W. Upp, engineer in charge of drafting room, General Electric Company, Schenectady, N. Y.

OBITUARY.

MR. A. G. BOWERS.—We regret to note the death of this well-known man, Mr. Alfred Graham Bowers was born at Port Huron on March 31, 1870. As a young man he entered the employ of the Bell Telephone Company, at Detroit, which position he subsequently left to enter the printing business at Montreal and while there he pursued the study of electricity. Returning to Port Huron, he entered the employ of Mr. D. J. Stevenson, an electrical contractor at Port Huron, where he gained considerable experience in general wiring and construction work. He was subsequently in the employ of Mr. E. C. Lombard, a construction contractor at Jackson, Mich.; was superintendent of the Whitehall, Mich., electric light plant. Leaving Whitehall he took up sales work and was successively identified with the Bryan-Marsh Electric Company as its Iowa and Minnesota representative, and the Ewing-Merkle Company of St. Louis, in the same territory. In the fall of 1903 he entered the employ of the Fort Wayne Electric Works as sales representative in Iowa, which position he held up to the time of his death. He died at Des Moines, Iowa, on Jan. 21, of pneumonia, after a few days' illness. In 1901 he married Miss Lillian Scoville, of Battle Creek, Mich., who survives him. His mother, Mrs. A. Bowers, and several married sisters live at Cass City, Mich. Mr. Bowers was widely known among the central station men and representatives of other electrical supply house in his territory, among whom he had many warm admirers, who will miss his genial and sincere friendship. Mr. Bowers was a member of the Knights of Maccabees and the United Commercial Travelers' Association. The funeral was held at Port Huron, Mich., Jan. 23.

MR. W. C. WHITNEY.—We note this week with deep regret the death, following an operation for appendicitis, of Mr. W. C. Whitney, formerly Secretary of the Navy under President Cleveland, and the great reorganizer and consolidator of the street railway system of New York City. Mr. Whitney, who was 64 years of age, came first into prominence as corporation counsel for New York City and soon rose to a prominence in Democratic counsels which he maintained to the time of his death. It was not until after his splendid work in creating the modern American navy that he turned his attention to traction, and then with the aid of Messrs. H. H. Vreeland and Daniel Lamont he soon built up the network which now constitutes the greatest electric street railway system in the world, under the names of the Metropolitan and Interurban Street Railway Companies. In this manner, while developing conduit work, he became interested in electricity in general, and had a large share in the promotion of electrical automobilism through the Electric Vehicle Company and its sub-companies. In this work he continued to take a deep interest to the last. A year or two ago he also became interested in the Stanley Electric Mfg. Company and is understood to have held a large ownership until its absorption by the General Electric Company. Of Mr. Whitney's fame as a sportsman and public spirited associate in many movements it is unnecessary to remind our readers. It is likely that his son, Mr. H. P. Whitney, will continue to represent his interests in the important field of work and play referred to above, including also his interests in the Consolidated Gas Company.

Trade Notes.

WHITEHEAD MACHINERY CO., of Davenport, Ia., notes its removal to the third floor of the Hageboeck Building, West Second St., in that city.

MOORE ELECTRICAL CO., 52 Lawrence St., Newark, N. J., has issued a neat pamphlet in regard to its vacuum tube system of lighting. It is not illustrated.

ELECTRICAL SUPPLIES.—Mr. W. A. Hawkins, of Mt. Jackson, Va., has moved to Hagerstown, Md., with the object of opening a general electrical supply store, as well as to do house wiring, telephone work, etc.

SHEPHERD ENGINEERING COMPANY, of Franklin, Pa., has just opened a western office in the First National Bank Building, Chicago, of which Mr. L. J. Highland will be in charge, with the object of attending promptly to orders and inquiries for Shepherd engines in that part of the country.

QUEEN & COMPANY, INC., of Philadelphia, have issued a handsome and instructive circular celebrating the fifty years of their existence, 1853-1903. It gives a synopsis of the history of the house, illustrates some of its leading apparatus, etc., and gives views also of its laboratories, factories, etc.

THE WARD LEONARD ELECTRIC COMPANY reports a large increase in business in field rheostats during the last two weeks. It believes that the slightly dull season which seemed to have come over the electrical trade must have passed. They are about to issue new circulars covering theatre dimmers, speed controllers, etc.

HALLER MACHINE CO., of Chicago, Ill., 127-129 Fulton Street, has issued a handsome circular in regard to its metal letters for electric signs, complete electric signs, and other electrical specialties, novelties, etc. It gives full details and prices and should be seen by every one of our central station and isolated plant readers.

R. THOMAS & SONS CO., of East Liverpool, Ohio, has issued a neat price list and catalogue on high voltage transmission line porcelain insulators, all of which have been designed with great care and equal resultant success. The catalogue and list should be seen. It is a handsome publication and deals with meritorious appliances.

SMITH & HEMENWAY CO., of 296 Broadway, New York City, has completed arrangements with the Page-Storm Drop Forge Co. to handle its entire line of engineers' and drop forge wrenches. The latter concern makes a specialty of all kinds of drop forgings. The Smith & Hemenway Co. has ready a new catalogue on the subject and invites applications for it at once.

CHICAGO FUSE WIRE & MFG CO., of 358 Dearborn St., Chicago, etc., etc., has issued No. 15 of its admirable little series of catalogues and price lists. Its experience with tested fuse wire extends over 15 years, and its list now includes the latest ideas, practice and developments in that field. Special attention may be called to its "Union" fusible links, "Union" switch outlet boxes, etc.

FARWELL, OZMUN, KIRK & COMPANY, of St. Paul, Minn., one of the leading wholesale hardware firms of the northwest, have opened an electrical supply department. Mr. J. S. Webster, who has been for many years engaged in the design, sale and installation of apparatus while located in Minneapolis, has become manager of the new department and would like to have descriptive circulars and prices from all manufacturers of standard electrical supplies and specialties.

THE S. H. COUCH COMPANY, 156 Pearl Street, Boston, Mass., has issued a four-page circular, describing its "Workwell" Telephone. These telephones are put on the market at very moderate expense and the illustrations portray a good-looking pair of instruments. Included in the circular are the specifications of the instrument making good reading for people desiring telephones for communication between house and stable, or between office and shipping room, or between any two points.

PITTSBURGH TRANSFORMERS.—Mr. A. H. Mustard, 120 Liberty St., New York, sales agent for the Pittsburgh Transformer Company, recently sent out some interesting literature regarding these well known transformers. In one of the circulars it is pointed out that 85 per cent. of the people who bought Pittsburgh transformers five years ago are buying them to-day. Another circular gives illustrations of three styles of transformers, specifications of each being given. These transformers have acquired a standing due largely to their merit, but the efforts of the sales department have, of course, contributed largely to their wide use.

THE CALCULAGRAPH COMPANY has issued a little card for keeping accurate track of the regulation of the Calculagraph. This is arranged so that an entry is made on the card as to whether the Calculagraph runs fast or slow and as to the extent and affords a means for keeping tab so that the Calculagraph may be regulated exactly. Incidentally, the card is a good thing for a man to have who wishes to regulate his watch and know that it is running properly. The card, of course, merely affords an opportunity for making an entry of the variation of a watch so that the variation may be carefully noted.

WESCO SUPPLY CO.—The new price book just issued by The Wesco Supply Co., of St. Louis, covering its No. 50 Catalogue, has been sent out to all in the trade who has a No. 50 book. Anyone who has not received this catalogue can secure it by writing to the concern. In addition to the latest market prices on all articles shown in the above catalogue, the price book contains several lines of new goods, and a copy of the latest rules of the National Board of Underwriters. These rules will be found very useful as a ready reference, and the Wesco people have inserted them for the special convenience of their customers.

WIRE REELS.—Messrs. Eugene Conard & Sons, Elizabeth, N. J., manufacture reels of all sizes for wire and cable. These reels are made with special machinery of the firm's own design. The strength of reels depends much upon how the nails are clinched in the building up. This firm recognized the importance of this little detail and clinches each nail separately by hand, thus securing the strongest possible structure. The firm aims to produce the best reel possible, and many of its reels are being used by the larger wire concerns. It has ample facilities for getting out orders promptly, and can ship either by rail or water.

NATIONAL WIRE CORPORATION.—The New York offices of this important concern have been removed to Room 1103, Engineering Bldg., 114 Liberty St., with Mr. Richard C. Smith as New York sales agent, who says: "We shall be pleased to receive all inquiries at our new office, and will be prepared at all times to furnish information or to make quotations when desired. Our New Haven mills are now in full operation, producing a large variety of wire products, including wire rope, galvanized telephone and telegraph wire, wire strand, tinned and coppered market wire, bright and annealed market and stone wire, bright and coppered screw stock, tinned mattress wire, black, coppered and liquor drawn spiring wire, and a great variety of special and miscellaneous wires for the jobbing and manufacturing trade."

MR. CHARLES E. MILLER, the enterprising New York jobber of automobile and bicycle material, has leased the properties 316 and 320 North Broad St., Philadelphia, from Jan. 1. From this branch he will conduct both a wholesale and retail business. It is his intention to make elaborate improvements in this store, and make it the most attractive of its kind in the country. As there are large show windows in the front of these stores he will have an excellent opportunity to make a fine display, and he intends to treat Broad St. promenaders to an automobile show of the continuous performance order. The same energy and business acumen that have brought him such a large measure of prosperity, both in his main salesrooms at 97-101 Reade St., New York, and his retail branch at Thirty-eighth St. and Broadway, New York, will undoubtedly crown his Philadelphia enterprise with success.

THEATRE ATMOSPHERES.—The ventilation and heating of a theatre presents a problem not easily mastered by the ordinary heating engineer. In a crowded auditorium of this kind ventilation is the all-important question. It may be a simple matter to heat the building to a required temperature before the curtain rises, but to maintain a constant temperature and a pure atmosphere while the play progresses is not so easily accomplished. The heat given off from the bodies of the closely-seated audience is sufficient to raise the temperature in the house from 5 to 10 degrees during the performance. Fresh air to breathe must be supplied constantly to the occupants and the impure air must be removed. Evidently a system giving a forced circulation of air is necessary to meet those requirements. A good example of this system is the recent installation in the New Franklin Sq. Theatre, at Worcester, Mass. The heating and ventilating apparatus consists of an electrically-driven fan and heating coils, located in a corner of the basement. Fresh air is drawn from the outside and circulated through coils of steam pipes enclosed in a fire-proof casing and distributed through ducts by means of the fan to the desired parts of the theatre. There are plenum chambers under the orchestra floor and first balcony from which air is admitted through openings in the chair legs giving an even distribution throughout the house. The low velocity with which the air enters prevents annoyance from draughts. The foul air is exhausted through grills in the dome of the theatre and by means of an electric exhaust fan is discharged through the roof. The B. F. Sturtevant Company, of Boston, Mass., was the heating and ventilating engineer, and the apparatus installed is of its manufacture.

Record of Electrical Patents.

UNITED STATES PATENTS ISSUED JANUARY 26, 1904.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., N. Y.]

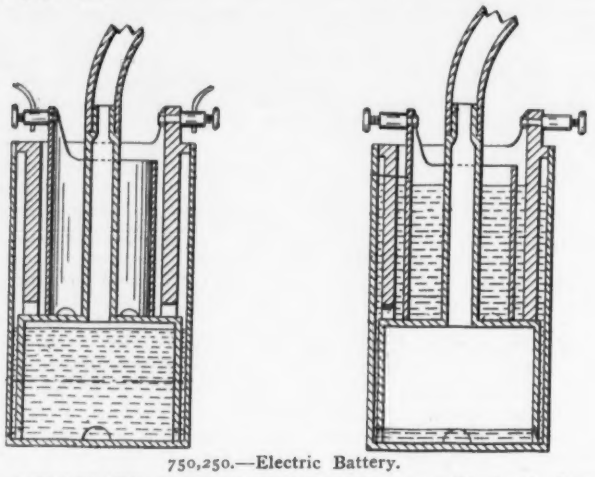
750,250. ELECTRIC BATTERY; Winfield S. Bryan, Cincinnati, Ohio. App. filed Sept. 28, 1903. An inverted cup connected by a tube with a source of air pressure, is located in the bottom of the cell and while the battery is not in use, the liquid of the cell is allowed to flow under the edges of the cup and fill it, thus covering the electrodes located above the cup; when the battery is to be put into use, air pressure drives the liquid out of the cup into the cell.

750,268. ELECTRIC SIGNALING APPARATUS; William E. Decrow, Boston, Mass. App. filed April 29, 1901. (See page 272.)

750,269. ELECTRIC SIGNALING APPARATUS; William E. Decrow, Boston, Mass. App. filed June 17, 1901. (See page 272.)

750,270. ELECTRIC SIGNALING APPARATUS; William E. Decrow, Boston, Mass. App. filed Sept. 27, 1901. (See page 272.)

750,288. RINGER; Anton M. Knudson, Chicago, Ill. App. filed June 6, 1902. (See page 272.)



750,250.—Electric Battery.

750,289. TELEGRAPH INSTRUMENT STAND; James W. Leech, Staunton, Va. App. filed Jan. 6, 1903. A stand for a telegraph instrument embodying a sounding box and reflecting board.

750,296. ELECTRIC RAILWAY SIGNAL; William V. Moak, Albany, N. Y. App. filed Dec. 8, 1902. Details.

750,309. ANNUNCIATOR; Lambert Schmidt, Weehawken, N. J. App. filed Aug. 28, 1901. The construction relates to the shutter-tripping mechanism.

750,352. OUTLET BUSHING FOR JUNCTION BOXES; Frederick W. Erickson, Boston, Mass. App. filed Oct. 5, 1903. A nut adapted to screw onto the end of the conduit carries a sheet metal flared rim for the end of the conduit.

750,361. ELECTROMETALLURGY OF IRON OR STEEL; Henri Harmet, St. Etienne, France. App. filed Sept. 30, 1901. (See page 274.)

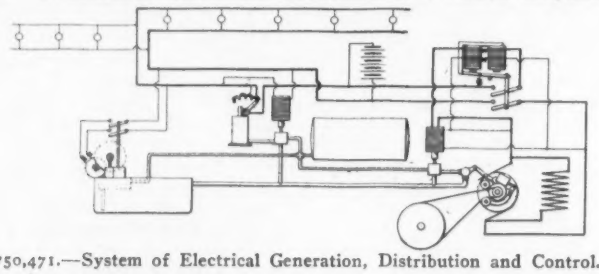
750,368. TROLLEY FOR ELECTRIC RAILWAY CARS; Charles J. Johnson, St. Louis, Mo. App. filed May 14, 1903. Details.

750,421. ELECTRIC BRAKE; George C. Anthon, Medford, Mass. App. filed Nov. 30, 1901. A liquid lock and release for the brake and means for controlling the same; also certain improvements in electro-magnetic clutches by which a brake winding drum is brought into frictional engagement with a driven axle.

750,422. ELECTRIC BRAKE; George C. Anthon, Medford, Mass. App. filed April 11, 1902. The brakes are actuated by current from a storage battey, the battery being charged by the line current, with provision also for operating the brakes from the line.

750,454. SYSTEM OF ELECTRICAL DISTRIBUTION; Josef H. Hallberg, New York, N. Y. App. filed Oct. 16, 1903. As a means for balancing the current in individual circuits of a multi-voltage system, a pair of motors having their armatures driven at the same speed and connected to supply the required voltages, and the field magnet of the motors connected so that the field of one motor will receive current from the circuit in which the armature of the opposite motor is included.

750,458. OVERHEAD TROLLEY ATTACHMENT; Charles Holyland, Sr., Pittsburg, Pa. App. filed June 6, 1903. Details of a device to retain the wheel on the wire.



750,471.—System of Electrical Generation, Distribution and Control.

750,471. SYSTEM OF ELECTRICAL GENERATION, DISTRIBUTION AND CONTROL; Lamar Lyndon, New York, N. Y., and Elmer A. Sperry, Cleveland, Ohio. App. filed Jan. 17, 1903. Regulating mechanism for a system of lighting in which the generator is driven from the car axle; the regulating being accomplished through a fluid actuated belt-tightener.

750,492. ELECTRIC CLOCK; Fred Schmidt, Oak Station, Pa. App. filed May 9, 1903. Details.

750,497. SYSTEM OF ELECTRICAL GENERATION, DISTRIBUTION AND CONTROL; Elmer A. Sperry, Cleveland, Ohio. App. filed Dec. 5, 1902. A modification of patent 750,471.

750,500. SYSTEM OF ELECTRICAL GENERATION, DISTRIBUTION AND CONTROL; Elmer A. Sperry, Cleveland, Ohio. App. filed July 1, 1903. Relates to the preceding system.

750,509. ELECTRICAL CONDUCTOR; William H. Wherry, Cleveland, Ohio. App. filed Nov. 3, 1902. The bond heads are welded to the rails.

750,510. PROCESS OF FORMING ELECTRICAL RAIL BONDS DIRECTLY IN PLACE ON THE RAILS; William H. Wherry, Cleveland, Ohio. App. filed Jan. 22, 1903. The process consists in applying heat to the head of the bond while it is in contact with the rail, until the latter is melted and becomes alloyed with the bond.

750,522. APPARATUS FOR BONDING RAILS; William B. Cleveland, Cleveland, Ohio. App. filed Oct. 30, 1902. A sheet metal sleeve embraces the middle portion of the bond to protect it when confined inside of the fish-plate.

750,525. TRANSFORMER; Augustine R. Everest, Lynn, Mass. App. filed Aug. 11, 1902. A transformer core made of two bowed members hinged together at one end and having engaging extensions at the other end, the coils being slipped over the members when they are open.

750,543. HEAT ALARM; Howard F. Jones, Wilson, N. C. App. filed April 13, 1903. Details.

750,549. SYSTEM OF ELECTRICAL GENERATION, DISTRIBUTION AND CONTROL; Lamar Lyndon, New York, N. Y. App. filed Jan. 22, 1903. In a train lighting system the electro-magnetic device by which the speed of the generator is controlled, is actuated by current from the battery, so that as the voltage of the battery rises in charging, the speed of the dynamo is reduced.

750,550. SYSTEM OF ELECTRICAL GENERATION, DISTRIBUTION AND CONTROL; Lamar Lyndon, New York, N. Y. App. filed July 18, 1903. Relates to the regulating devices in a train lighting system.

750,563. PROCESS OF COVERING WIRE; James C. Anderson, Jersey City, N. J. App. filed April 30, 1903. Copper ribbon is covered by making an elongated envelope of paper, then covering the envelope, inserting the ribbon and closing the envelope.

750,584. PROCESS OF ADMINISTERING ELECTRICAL VIBRATIONS; Fred H. Brown, Los Angeles, Cal. App. filed Aug. 25, 1902. Electrical impulses whose periods of vibrations are synchronous with musical vibrations, are created by causing musical sounds to vary the resistance of an electric circuit; an induced current created therefrom is administered therapeutically.

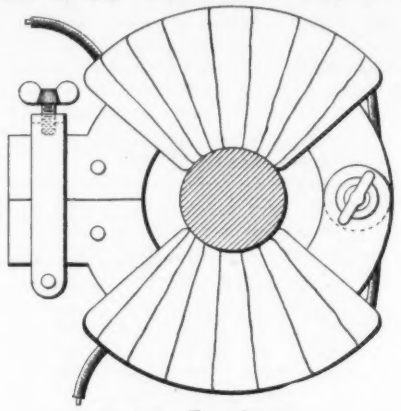
750,594. MAGNET; Henry F. Campbell, Boston, Mass. App. filed May 16, 1901. A magnet comprising parallel horseshoe-shaped bars arranged to have an air space between them and a pole piece adjustably mounted upon the lower ends of the bars.

750,646. COMBINED ELECTRICAL BATTERY RECEPTACLE AND BELL SUPPORT; William A. Harvey, Scranton, Pa. App. filed Sept. 9, 1903. Details.

750,689. PLUG FOR TELEPHONE-SWITCHBOARDS; Frank D. Pearne, Chicago, Ill. App. filed April 20, 1903. (See page 272.)

750,704. TELEPHONE SWITCHING AND SIGNALING APPARATUS; Malcolm C. Rorty, Dedham, Mass. App. filed Jan. 3, 1902. (See page 272.)

750,720. INCANDESCENT LAMP; Walter A. Springall, San Antonio, Tex. App. filed June 25, 1903. A multi-filament lamp having contacts in its neck by means of which the filaments can be successively thrown into circuit by twisting the neck in its socket.



750,525.—Transformer.

750,722. INSULATOR; Louis Steinberger, New York, N. Y. App. filed May 25, 1903. A knob of insulating material covered by a metal casing and having an opening through which the conductor is to be threaded.

750,723. BINDING POST; Louis Steinberger, New York, N. Y. App. filed June 22, 1903. The post has two threaded portions succeeding each other and of different diameters, each one carrying its own wire clamping devices.

750,733. TROLLEY POLE; John J. Tartt, Los Angeles, Cal. App. filed March 30, 1903. An arm carrying the wheel is pivoted to the upper end of the pole and actuated by its own spring, the construction being such that vibrations of the pole will not be communicated to the arm.

750,753. ELECTRIC FURNACE; Rámon Chavarria Contardo, Sèvres, France. App. filed Aug. 24, 1900. (See page 274.)

750,765. ELECTRIC MOTOR; Thaddeus W. Heermans, Chicago, Ill. App. filed Dec. 4, 1899. Both the field magnet and armature are rotating parts, to each of which a pulley is attached and a speed-controlling device is interposed in such a manner that as the speed of one part rises, the other falls, without varying the power of the motor.

750,769. TELEPHONE-SERVICE APPARATUS; Uriah S. Jackson, Ossipee, N. H. App. filed May 31, 1902. (See page 272.)

750,770. TELEPHONE-SERVICE APPARATUS; Uriah S. Jackson, Boston, Mass. App. filed April 22, 1903. (See page 272.)

750,777. APPARATUS FOR SELECTIVE SIGNALING; Kenneth Moodie and John S. Small, Chicago, Ill. App. filed Sept. 13, 1902. A number of pairs of helices, each comprising a main circuit helix and an operating circuit helix, means for operatively neutralizing the effect of any main circuit helix by sending a current over the operating circuit, certain of the helices being relatively so arranged and so energized as not to be neutralized by an operating current which will result in neutralizing another of the helices.

750,781. SAFETY DEVICE FOR RAILWAY SERVICE; Edmund B. Powers, New York, N. Y. App. filed March 5, 1903. A projection from the locomotive is struck by an arm at the roadside and moved a certain distance to actuate a certain signal by the particular location of the arm at the roadside.

12,195. ELECTRICAL ACCUMULATOR; Chaimsonovitz Prosper Elieson and Vladimir de Bobinsky, Paris, France. App. filed Oct. 26, 1903. (See page 272.)

TROLLEY WIRE

MAGNET AND WEATHERPROOF WIRES

THE MAGNET WIRE CO.

80 William Street, New York

ATLANTIC INSULATED WIRE & CABLE CO.

WIRES AND CABLES,

FOR SUBMARINE, AERIAL, UNDERGROUND AND INTERIOR USE.

FACTORY, STAMFORD, CONN.

120 LIBERTY STREET, NEW YORK CITY.

HENRY C. TOWNSEND
Formerly Principal Examiner Electrical Division U. S. Patent Office.
DELBERT H. DECKER
Late Assistant Examiner Electrical Division U. S. Patent Office.
TOWNSEND & DECKER Solicitors of U. S. and Foreign Patents
141 Broadway, New York.
Expert Opinions on the scope and validity of Patents

FOR CARD INDEX ELECTRICAL WORLD AND ENGINEER JAN. 30, 1904.

Institute Annual Dinner	208
The Automobile Club Annual Dinner	208
Equipping the Erie Canal Electrically	208
World's Fair Electric Railway Test Commission	208
The Siskiyou Power Transmission	209
Electrical Foucault Pendulum Systems. By Ernest K. Adams	211
The Theoretical Determination of Power Curves. By William J. Berry	215
Sports in Aid of Spanish War Veterans	216
The Gilbert Tercentenary Picture	217
Electrification of an English Steam Railway	217
International Electrical Congress at St. Louis	219
Convention of the Northwestern Electrical Association	220
The Lamme Single-Phase Series Motor	225
Theories in Wireless Telegraphy. By Reginald A. Fessenden	227
Digest of Current Electrical Literature	230
Electric Heating Equipment of a Modern Hat Factory. By Max Lowenthal	235
Central Station Feeder Regulators	237
Practical Study of Transformer Design	238
Telephone Card Index Bracket	238
Electricity in Typesetting and Printing	239
High Pressure Gas Distribution by Gas Power	239
Northwestern Electrical Convention Notes	240
Stilwell-Bierce & Smith-Vaile Co.'s Affairs	241
Milling Machine for Brass Trolley Wire Hangers	242
Positive Self-Feed Upright Drill	242
New Westinghouse Oil Switch	243

WM. A. ROSENBAUM
PATENT ATTORNEY
140 Nassau St., New York City
(Formerly in the Times Building)

THOMAS J. JOHNSTON
COUNSELLOR AT LAW
11 Pine St., NEW YORK CITY
Patent Causes Patent Soliciting

"AMERICAN"
STORAGE CELLS Are the Best
Send for Descriptive Circular.
AMERICAN BATTERY CO.
172 So. Clinton St., Chicago, Ill.
Established 1889.

PATENTS
Law Offices
OF
DYER & DYER
31 Nassau Street
NEW YORK CITY
Patent Soliciting and Litigation
Electrical Cases a Specialty

LAVA INSULATORS machined into any shape
CORRESPONDENCE SOLICITED
P. J. KRUESI, Chattanooga, Tenn.

DISTRICT MESSENGER BOXES AND FIRE ALARM
VIADUCT CO.
BALTIMORE, MD. (3)

EUGENE A. BYRNES, Ph. D., Late Principal Examiner, Division of Metallurgy, U. S. Patent Office.
CLINTON PAUL TOWNSEND, B. S., Late Examiner Electro-Chemistry, U. S. Patent Office.
BYRNES & TOWNSEND
Patent Lawyers
Experts in Electricity, Metallurgy, Chemistry, Electro-Chemistry.
National Union Building, 918 F Street.
Rooms 58, 59, 60, 61. Washington, D. C.

GOEPEL & NILES
COUNSELORS AT LAW
REGISTERED PATENT ATTORNEYS
U. S. and Foreign Patent Trade Marks, Copyrights
290 Broadway, Dun Bldg., New York.

GENUINE HARD PORCELAIN
EMPIRE CHINA WORKS
144 TO 156 GREEN STREET. BROOKLYN, N. Y.
(GREENPOINT)
FOR ELECTRICAL SPECIALTIES

JOHN A. STRALEY.
LOUIS B. HASBROUCK.
G. AUGUSTUS DIETERICH.
STRALEY, HASBROUCK & SCHLOEDER, COUNSELORS AT LAW,
Solicitors of American and Foreign Patents
PATENTS AND PATENT CAUSES.
257 BROADWAY, NEW YORK, N. Y.
PATENTS, DESIGNS, TRADEMARKS, LABELS AND COPYRIGHTS.

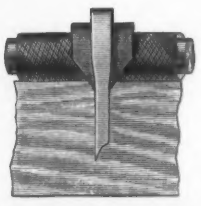
WRITE FOR OUR CATALOGUE OF ELECTRICAL BOOKS

Vulcanized Fibre For ELECTRICAL INSULATION

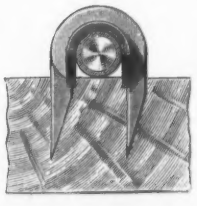
in Sheets, Tubes, Rods and Special Shapes

CORD ADJUSTERS, INSULATING STAPLES, GEAR BLANKS,
NOISELESS GEARS, FRICTION PULLEYS, ROLLERS, WASHERS, ETC.

Send for Catalogue and Samples



American Vulcanized Fibre Co.
WILMINGTON, DEL.



POSITIONS WANTED.

The rate for "Position Wanted" advertisements of forty words or less is one dollar an insertion; additional words two cents each, payable in advance. Remittance and copy should reach this office not later than Tuesday morning for the next succeeding issue.

POSITION WANTED.—As manager or superintendent; fourteen years' practical experience installing and operating light and power plants, water power and steam. Address No. 1282, care Electrical World and Engineer, New York.

POSITION WANTED.—By civil and electrical engineer; graduate of German University; 26 years old; has had 6½ years' practical experience in the manufacture of electrical and other machinery; splendid draughtsman and good accountant and business man; first-class references; not proficient in English. Address No. 1274, care Electrical World and Engineer, New York.

POSITION WANTED.—By practical man as superintendent of electric light plant; have had sixteen years' experience in constructing lighting plants; thoroughly familiar with both direct and alternating current machinery and fully capable of managing such a business so as to get the best results. Address No. 1218, care Electrical World and Engineer, New York.

POSITION WANTED.—By a man having 15 years' practical experience and familiar with direct and alternating current systems; would like to take charge of lighting plant in small city or an isolated plant. Address No. 1297, care Electrical World and Engineer, New York.

POSITION WANTED.—By electrical engineer, graduate of a German college for mechanical and electrical engineering; competent man in designing D. C. machinery with practical experience in this country; desires to change his position. Address No. 1294, care Electrical World and Engineer, New York.

POSITION WANTED.—By electrical engineer, college graduate; extensive experience installing and operating electric light and power plants, pole line construction, house wiring, meters, etc.; able mechanic and armature winder; prefer installing or superintendent of lighting plant. Address No. 1288, care Electrical World and Engineer, New York.

WANTED

YOU, who are troubled with sparking and cutting of commutators, to use

The only article that will PREVENT SPARKING. Will keep the commutator in good conditon and PREVENT CUTTING.

ABSOLUTELY WILL NOT GUM THE BRUSHES . .

It will put that high gloss on the commutator you have so long sought.

For Sale by all Supply Houses.

SAMPLE STICK SENT FREE

K. McLENNAN & CO.

Sole Manufacturers (3)

100 WASHINGTON ST. CHICAGO, ILL.

IF YOU WANT AN ARTICLE THAT WILL REPEAT ITSELF, TRY

U. S. METAL POLISH

FOR POLISHING ALL KINDS OF METALS.

Sold by Dealers. Samples Free.
Geo. W. Hoffman, MANUFACTURER, 293 E. Washington St., Indianapolis, Ind.

WHY DON'T YOU —— Put a Little

Hare's Commutator Compound

on that Sparking Motor, and save the Commutator?
Save your time too. Both cost money.

Big Stick, 35c. Enough to show you FREE.

SOUTHWORTH & HARE, Indianapolis, Indiana

MECHANICAL DRAWING AND DESIGN

$3 Postpaid

Do you want to thoroughly master the principles and practice of Drawing and Designing as required in the shops and drafting rooms of the engineering, electrical, machinery and kindred trades? If so, send for **Rogers' Drawing and Design.** a practical and complete self-instructor for home-study.

506 pages, 610 illustrations. Clearly printed on superfine paper and handsomely bound in black vellum cloth, with full gold edges. *The money paid will be refunded if the book is not found to be satisfactory.*

Specimen pages and a complete list of contents sent postfree upon request

THEO. AUDEL & CO., Educational Book Publishers, 63 Fifth Ave., New York

POSITION WANTED.—By young man as electrician; has had four years' practical experience managing dynamos and motors; electric lighting, both incandescent and arc; capable of handling men and taking charge of all electrical apparatus; best of references can be furnished. Address No. 1289, care Electrical World and Engineer, New York.

POSITION WANTED.—Electrical and mechanical engineer is open for engagement; 10 years' experience in constructing and operating large power and lighting plants; competent to take entire charge of large plant. Address No. 1290, care Electrical World and Engineer, New York.

POSITION WANTED.—With an engineering or construction company by an electrician of 11 years' practical experience in construction work, especially installation of apparatus in large mills, manufactories, etc.; excellent references as to character and ability; age 30. Address No. 1296, care Electrical World and Engineer, New York.

POSITION WANTED.—As house electrician, by practical man of seven years' experience in wiring and dynamo running; best of references furnished as regards previous work and reliability; thorough knowledge of all branches of D. C. work. Address Lowell, 202 West 143 St., New York, N. Y.

HIGH GRADE ADVERTISING MAN

wants position as Advertising Manager with concern whose advertising requires technical knowledge; am technical graduate with considerable engineering experience; now assistant advertising manager of large company; thoroughly understand trade-paper, general and mail-order advertising, advertising management, etc.; capable, energetic; best references. Box 3639, Boston.

(*Continued on pages 86 and 87.*)

ALTERNATING GENERATORS.

60 CYCLES.

1100 or 2200 volts, 7200 Alternations.

	Lt.		Speed.
2	300	Gen. Elec., 15-K.W., comp., single phase, with exciter	720
1	500	Wood, 25-K.W., comp., iron clad armt., single phase, with exciter	720
1	600	West., 30-K.W., comp., toothed iron clad armt., single ph., with exciter	825
1	750	Wood, 37½-K.W., comp, iron clad, armt., single phase, with exciter	525
1	900	West., 45-K.W., comp., toothed armt., 2 phase, 1100 v., with exciter	720
1	1200	West., 60-K.W., toothed armt., single ph., comp., with exciter	720
1	1500	Warren-Medberry, 75-K.W., 2 ph., ind. type, with exciter, 2200 v.	600
1	1500	Stan., inductor, 75-K.W., 2 phase, 1100 or 2200 v., with exciter	900
1	1500	West., 75-K.W., comp., distributed winding, 2 ph., 1100 v., with exciter	900
2	1500	West., 75-K.W., 2 ph., 2200 v., d. c. to 14x14 Gates 4-valve aut., engine, complete with exciter	300
1	1500	Wood, 75-K.W., comp., slotted armt., with exciter	600
1	2400	Gen. Elec. 120-K.W., 3 phase, 2200 or 3300 v., with exciter	600

125-133 CYCLES ALTERNATING GENERATORS.

	Lt.		Speed.
1	650	Wood, 33-K.W., comp.,	1680
1	750	West., 37½-K.W.	1650
1	750	Wood, 37½-K.W., comp.	400
1	900	Warren-Medberry, 45-K.W., inductor type	1300
1	1000	Wood, 50-K.W., comp.	1400
2	120	West., 60-K.W., toothed armt., comp.	1650
1	1500	Wood, 75-K.W., comp.	1050
1	1500	Stanley, inductor type, 75-K.W., 1100 or 2200 v., 2 phase	
1	1800	West., 90-K.W., comp., toothed armt.	1500
1	2400	Gen. Elec., 120-K.W., type A 120, latest type, comp., toothed armt	1070
2	2400	Gen. Elec., 120-K.W., type A S, comp., slotted armt.	1070

LATEST TYPES OF (second-hand) ELECTRICAL MACHINERY

FOR SALE AT BARGAIN PRICES

GREGORY ELECTRIC CO.

54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing complete list of apparatus with NET PRICES. All machines fully guaranteed.

	Lt.		Speed.
2	2400	West., 120-K.W., comp., self-oiler, toothed armt.	1375
1	4000	Stan., inductor type, 200-K.W., 1100 or 2200 v., 2 phase	670
1	8000	West., 400-K.W., slotted armt., 3 bearings, distributed windings	445

110 TO 125 VOLT GENERATORS.

DIRECT CURRENT.

	Lt.		Speed.
4	10	West. Elec., M. P.	1350
1	25	Triumph, M. P., comp.	1400
1	35	Crocker-Wheeler	1200
3	40	Gen. Elec., type I B	1900
1	45	Excelsior, M. P.	900
3	45	West., M. P., comp.	1800
1	45	Gen. Elec., type C E	2050
1	50	Crocker-Wheeler	1150
1	50	C. & C., comp., self-oiler	1550
1	50	Northern, M. P.	2100
3	55	Edison, self-oiler, 3-K.W.	1900
2	60	Hobart, M.P., comp., s-o.	1200
1	75	Hobart, M.P., comp.	1300
2	75	West., M. P., comp.	1650
1	80	Riker, M. P., comp., s-o.	1100
1	80	New Eng., multipolar	1450
1	80	Perrett, multipolar	950
2	80	Card, multipolar	1250
1	80	Crocker-Wheeler, comp.	1350
1	100	Card, M. P.	1000
2	100	Hobart, M. P., comp.	1500
2	100	Northern, M.P., comp.	1600
2	100	Com., M. P., comp.	1350
1	150	Eddy, M. P.	1650
1	120	West. Elec., M.P., comp.	750
1	180	Triumph, M.P., comp.	1200
1	210	Triumph, M.P., comp.	1100
1	210	Eddy, M. P.	1100
1	210	Sprague-Lundell, M. P.,	1050
1	210	Crocker-Wheeler, M. P.	1000
2	210	Edison, s-o., 12-K.W.	1500
1	250	Fuller, M. P., comp.	580
1	300	Perrett, M. P., comp.	750
1	300	Phoenix, M. P.	1100
1	300	Ahlms-Edwards, M. P.	825
2	350	Edison, 20-K.W., comp.	1400
2	350	C. & C., M.P., 20-K.W.	800
1	350	Card, M.P., comp.	800
1	400	Crocker-Wheeler, M. P.	1150
1	400	Triumph, M. P., comp.	950
1	400	Crocker-Wheeler, M. P.	875
1	400	Northern, 22½-K.W.	1000
2	450	Edison, 25-K.W., s-o.	1300
1	450	Gen. Elec., M. P., comp.	1100
1	450	Sprague-Lundell, M. P.	925
1	540	C. & C., M.P., 30-K.W.	700
1	540	Fisher, M.P., comp.	
2	540	Gen. Elec., M.P., comp.	1000
3	600	Card, M.P., comp.	850
2	700	Commercial, M. P., comp.	865
1	750	Card, M. P., comp.	750
2	800	Edison, 45-K.W., comp.	1000
1	900	Wagner, M. P., comp.	950
2	1000	Edison, s-o., 60-K.W.	700
1	1300	Walker, M. P., 75-K.W.	600
1	1300	Card, M. P., comp.	500
1	1800	Edison, 100-K.W., s-o.	650

DIRECT CONNECTED UNITS

	Lt.		Speed.
1	100	G. E., 6 pole, comp., d.s. to 12x13 Weston aut. engine, 60-K.W., 125 v.	275
1	1350	Waddel-Entz, 80-K.W., d. c. to Ball engine, 15x14, 125 v.	265
1	1350	Ft. Wayne, comp. d. c. to 13x14 Buckeye vert. engine, 80-K.W., 125 v.	275
2	130	Gen. Elec., M. P., 6 pole shunt, d. c. to Ames tandem comp. 11x17x12 aut. engine, 12 v.	270
1	2500	West. Elec., M.P., comp. for d.c., brand new, 150-K.W., 125 v.	240
1	40	Commercial, M.P., d.c. to 11x12 aut. Chandler-Taylar engine, 250 v.	300
1	75	Siemens & Halske, Churchward type, M.P., brand new, for d. c., 250 v.	300
2	75	West., 60 cycle, 2 phase, 2200 v., d. c. to 14x14 Gates 4-valve aut. engine, complete with exciter	300

220 TO 250 VOLT GENERATORS.

	K.W.		Speed.
1	12	Crocker-Wheeler, M. P.	1000
1	12	Card, M. P., comp.	800
1	12	Westinghouse, M. P.	1400
1	15	Edison, self-oiler	1400
1	20	Western Electric	150
1	20	Edison, self-oiler, comp.	1400
1	20	Wagner, multipolar	1200
1	20	Keystone, M. P., comp.	950
1	20	Eddy, M. P., comp.	950
1	20	Diehl, M. P., comp.	925
1	25	Crescent, multipolar	1000
1	25	Commercial, s-o, comp.	1380
1	30	Western Elec., M. P.	600
1	30	Triumph, M. P., comp.	950
1	37½	Keystone, M. P., comp.	800
1	40	C. & C., M. P., comp.	750
1	40	Crocker-Wheeler,	950
1	40	Eddy, M. P., comp.	850
1	40	Keystone, M. P., comp.	900
1	45	Am. Engine C., M. P.	750
2	45	Edison, comp., self-oiler	1000
1	45	Gen. Elec., M. P., comp.	925
1	59	Eddy, M. P., comp.	850
1	50	Triumph, M. P., comp.	900
1	55	Fuller multipolar, comp.	750
1	70	Western Electric, comp.	585
1	75	C. & C., M. P., comp.	525
1	80	C. & C., comp., self-oiler	625
1	100	Edison, comp., self-oiler	650
1	100	Commercial, M. P., comp.	750
2	220	Eddy, M. P., comp,	700
1	125	Thompson-Ryan, M. P.	375
1	125	Siemens & Halske, M. P.	
2	150	National, M. P., comp.	350
1	200	Eddy, M. P., comp.	500
1	300	Western Elec., M. P.	480

500 TO 550 VOLT GENERATORS.

	K.W.		Speed.
1	60	Edison, comp., self-oiler, new armt. and commutator	700
1	62	T.-H., D 62, s-o., comp.	900

DYNAMOS ❁ MONEY SAVERS ❁ ENGINES

110 VOLT GENERATORS AND MOTORS

2—60-K.W. Edison bipolar.
2—45-K.W. Edison bipolar.
1—30-K.W. Loomis 4 pole.
1—21-K.W. Riker 4 pole.
1—17½-K.W. General Electric, 4 pole.
1—15-K.W. Edison bipolar.
1—12-K.W. Card 4 pole.
1—10-K.W. Detroit bipolar.
1—15-H.P. Riker, 4 pole motor.

220 VOLT GENERATORS AND MOTORS

1—120-K.W. C. & C. 6 pole.
1—60-K.W. Northern Electric, 6 pole.
1—50-K.W. Bullock, 4 pole.
1—16-K.W. Ft. Wayne, 4 pole.
1—60-H.P. Bullock, 4 pole motor.
1—15-H.P. Keystone bipolar motor.
1—10-H.P. Excelsior bipolar motor.
1—7½-H.P. American Ball 4 pole.
1—5-H.P. Sprague, bipolar.
1—3-H.P. Belknap, 4 pole.

500 VOLT GENERATORS AND MOTORS

1—300-K.W. Westinghouse, 6 pole.
1—200-K.W. Edison bipolar.
2—175-K.W. Edison bipolar.
1—150-K.W. Westinghouse, 4 pole.
2—125-K.W. Westinghouse, 4 pole.
1—110-K.W. General Electric, 6 pole.
2—100-K.W. General Electric, 4 pole.
1—100-K.W. Westinghouse, 6 pole.
2—100-K.W. Edison bipolar.
4—75-K.W. General Electric, 4 pole.
1—75-K.W. Westinghouse, 6 pole.
3—47-H.P. Ft. Wayne 6 pole motors.
1—15-H.P. Crocker-Wheeler, 4 pole.
1—12-H.P. Edison bipolar.
1—7½-H.P. American Ball, 4 pole.
1—7½-H.P. T. H., type D.

DIRECT CONNECTED

500-K.W. G. E., 25 cy., 3 ph. & Allis Corliss engine.
300-K.W. (two) West., 2 ph., 60 cy., 2200 v., & Cross compound 4 valve engines.
300-K.W. Westinghouse, 8 pole, 550 v., & Cross compound 4 valve engine.
80-K.W. Jenney, 110 v., & Russell.
50-K.W. Walker, 110 v., & Russell.
50-K.W. (two) Am. Ball 220 volt, & engine.
25-K.W. G. E., 110 v., & Fisher.
7½-K.W., 6-K.W., 4-K.W., & 3-K.W. Northern Elec. dynamos, d.c. engines (new).

ALTERNATING

150-K.W. Warren, 60 cy., 2. ph., 2200 volts.
100-K.W. G. E., 3 ph., 60 cy., 2300 volts.
150-K.W. G. E., type A.M., 125 cy., 2300 volts.
100-K.W. G. E., type A.M., 125 cy., 1250 volts.
65-K.W. Stanley, 60 cy., 2 ph.
60-K.W. G. E., type A., 125 cy.
20-H.P. Westinghouse, 2 ph., 60 cy. motor.
7½-H.P. Westinghouse 2 ph., 60 cy.

ENGINES

3—17x28x18 Harrisburg, tandem.
3—11x17x14 Harrisburg, tandem.
1—24x48 St. Louis Corliss.
1—17½x32 Buckeye automatic.
1—20x20 Harrisburg, standard.
2—18½x18 Ide automatic.
3—14½x16 Buckeye, automatic.
2—17x24 Russell 4 valve.
2—15x20 Russell 4 valve.
1—13x21 Buckeye tangye bed.

BOILERS

4—72x18' return tubulars, 125 lbs.
2—72"x16' return tubulars, 125 lbs.
6—66"x16' return tubulars, 100 lbs.

Boilers **THOMPSON SON & CO., 114 LIBERTY ST., N. Y.** Equipments

MODERN ELECTRICAL MACHINERY FOR SALE.

DIRECT CONNECTED UNIT, 220 volts

50-K.W. American Ball Dynamo & Engine.

10 VOLTS DIRECT CURRENT
Dynamos or Motors

30-K.W. Bullock, M. P.
15-K.W. Eddy, M. P.
10-K.W. Eddy, M. P.
5-K.W. C. & C.
3-K.W. C. & C.
2-K.W. Lundell.
1-K.W. C. & C.

500 VOLTS DIRECT CURRENT
Dynamos or Motors

15-H.P. General Elec., M. P.
7½-H.P. General Elec., M. P.
5-H.P. Westinghouse.
5-H.P. Sprague.
2-H.P. General Elec.

220 VOLTS DIRECT CURRENT
Dynamos or Motors

40-H.P. Sprague, M. P.
25-H.P. Crocker-Wheeler, M. P.
20-H.P. Card.
15-H.P. C. & C.
15-H.P. Sprague, M. P.
10-H.P. General Elec.
10-H.P. Holtzer Cabot.
7½H.P. Card.
7½-H.P. Edison.
7½-H.P. C. & C.
5-H.P. Paragon, M. P.
5-H.P. Holtzer Cabot.
5-H.P. Crocker-Wheeler.
3-H.P. Diehl.
3-H.P. C. & C.
2-H.P. General Elec.
2-H.P. Diehl.
1½-H.P. C. & C.
1-H.P. Crocker-Wheeler.

ALTERNATING INDUCTION MOTORS.

2 Phase, 60 Cycles, 220 Volts

30-H.P. Type F Westinghouse.
15-H.P. Type C Westinghouse.
10-H.P. Type C Westinghouse.
7½-H.P. Type C Westinghouse.
5-H.P. Type C Westinghouse.
3-H.P. Type C Westinghouse.
2-H.P. General Elec.
1-H.P. Westinghouse.
½-H.P. General Elec., 220 or 110 v.
¼-H.P. General Elec.

2 Phase, 440 Volts, 60 Cycles

30-H.P. Westinghouse.
15-H.P. Westinghouse.
10-H.P. Westinghouse.
7½-H.P. Westinghouse.
5-H.P. Westinghouse.
3-H.P. Westinghouse.
1-H.P. Westinghouse.

3 Phase, 60 Cycles

5-H.P. Westinghouse, 220 volts.
2-H.P. Gen. Elec., 220 volts.
2-H.P. Westinghouse, 220 volts.
½-H.P. General Elec., 220 volts.
½-H.P. General Elec., 110 volts.

1 Phase, 60 Cycles

7-H.P. Wagner, latest type.
½-H.P. General Elec.
¼-H.P. General Elec.

1 Phase, 125 Cycles

3-H.P. Wagner, latest type.
2-H.P. Wagner, latest type.
1-H.P. General Elec.
½-H.P. Emerson.
1/10-H.P. Emerson.

Large stock of small motors, auto-starters, starting boxes, rheostats, switchboards, volt-meters, ammeters, etc.

I BUY, RENT AND INSTALL.—GEORGE BENDER, 137 CENTRE STREET, NEW YORK.

BARGAINS IN (second-hand) ELECTRICAL MACHINERY

We do not offer old, worn out machines fit for the Junk pile, but the LATEST TYPES of the leading manufacturers.

GREGORY ELECTRIC CO.

54-62 S. CLINTON ST. CHICAGO.

Send for our Monthly Bargain Sheet showing NET prices—all machines fully guaranteed.

K.W.		Speed.
1 75	Akron, M. P., 6 pole	900
2 75	Bullock, multipolar	900
2 75	Gen. Elec. M. P., 4, comp.	700
1 100	Edison, comp.	650
1 100	Siemens & Halske, M. P.	600
3 100	Gen. Elec., M. P., 4, comp.	650
1 100	Westinghouse, M. P., 6	650
1 120	Westinghouse, M. P.	625
1 200	Gen. Elec., M. P., 4, comp., s-o., three bearings	400
1 200	Thompson-Ryan, M. P.	525

ARC DYNAMOS.

Lt.	C.P.		Speed.
1 35	2000	T.-H., L D 2 ball	820
1 45	1200	Brush, No. 7.	1050
1 50	1200	T.-H., L D 12, new ball	820
2 50	2000	T.-H., M D 2, s-o., ring	820
1 65	2000	Brush, No. 8	950
1 75	1200	T.-H., M D 12, s-o,	820
1 75	1200	Wood	950
1 100	2000	Wood	600
1 125	1200	Brush, 6.6 amp.	700
2 125	2000	Brush, 9.6 amp.	500
1 125	1200	Excelsior	700

220 TO 250 VOLT MOTORS.

DIRECT CURRENT.

H.P.		Speed.
1 1	Crocker-Wheeler, self-oiler	900
1 1	Commercial, self-oiler	1200
1 1	Paragon, self-oiler	1100
1 2	Edison, self-oiler	1600
1 2½	Gibbs, multipolar	1250
1 3	Gibbs, M. P.	1400
1 3	Westinghouse, M. P.	1700
1 3½	Paragon, self-oiler	1000
1 5	Western Electric, M. P.	950
3 5	Gibbs, M. P.	1400
1 7½	Western Electric, M. P.	975
1 7½	Towle, M. P.	1050
1 7½	Commercial, M. P.	1300
1 7½	Gen. Elec., M.P., form H	800
1 10	Sprague-Lundell, M. P.	1175
1 10	Keystone, M. P.	1175
1 10	Lundell, M. P.	1060
1 15	Crocker-Wheeler, M. P.	810
1 15	Card, M. P.	700
1 15	Westinghouse, M. P.	1200
1 18	Edison, 15-K.W.	1150
1 25	Western Electric	525
1 25	Keystone, M. P.	725
1 25	Eddy, M. P.	725
1 25	Diehl, M. P.	750
1 30	Crescent, M. P.	800
1 40	Western Electric, M. P.	400
1 40	Keystone, M. P.	700
1 40	Triumph, M. P.	750
1 45	Crocker-Wheeler, M. P.	850
1 50	C. & C., M. P.	560
1 50	Eddy, M. P.	675
1 50	Keystone, M. P.	750

H.P.		Speed.
2 60	Edison, self-oiler	75
1 60	General Electric, M. P.	700
1 65	Triumph, M. P.	700
1 65	Eddy, M. P.	650
1 70	Fuller, multipolar	600
1 75	Sprague, self-oiler	500
1 85	Western Electric	500
1 100	C. & C., M.P., 6 pole	450
1 100	C. & C., self-oiler	450
1 125	Edison, self-oiler	550
1 135	Commercial, M. P.	675
2 150	Eddy, M. P.	600
2 200	National, M. P.	300

500 TO 550 VOLT MOTORS.

H.P.		Speed.
1 1	Crocker-Wheeler	1200
1 1	Diehl, self-oiler	1875
1 1	New England	1100
2 1½	Crocker-Wheeler	1550
2 2	C. & C., self-oilers	1350
1 2	New England, self-oiler	1200
1 2	Crocker-Wheeler	1100
1 2	Lundell	940
2 3	Gen. Elec., type C E	1800
2 3	Crocker-Wheeler	1100
1 3½	Roth, self-oiler, M. P.	950
1 4	Triumph, M. P.	1250
1 4	Perrett, multipolar	725
1 5	Northern, M. P.	1180
1 5	Amer. Engine Co., M. P.	1550
1 5	Westinghouse, M. P.	1500
3 5	Crocker-Wheeler	950
1 7½	Northern, M. P.	1500
1 7½	Crocker-Wheeler	1500
1 7½	General Electric, M. P.	1600
1 10	Perrett, M. P.	600
1 10	Northern, M. P.	1350
1 10	Triumph, M. P.	1100
1 10	Crocker-Wheeler	1275
1 10	General Electric, M. P.	1400

H.P.		Speed.
1 15	Kester, M. P.	1250
1 15	C. & C., self-oiler	975
1 15	Perrett, M. P.	1100
1 18	T.-H., D 15, self-oiler	1550
1 20	Kester	1400
1 20	S. & H., M. P., Churchward	900
1 20	Perrett, M. P.	700
1 20	Commercial, M. P.	900
1 25	New England, multipolar	900
1 25	Card, multipolar	500
1 35	Card, M. P., self-oiler	775
1 40	Wood, multipolar	750

ALTERNATING CURRENT MOTORS.

SINGLE PHASE. 125-133 CYCLES.

H.P.		Speed.
1 ½	Wagner, 104 v., aut.	2000
1 1	Fort Wayne, 104 volts	2500
1 1	Wagner, 208 volts, aut.	2000
2 1½	Wagner, 208 volts, aut.	2000
1 5	Wagner, 104 volts, aut.	2000
1 ½	Phillips, 104 volts	1800
1 ½	Holtzer-Cabot, 104 volts	2500
1 ½	Emerson, 104 volts	2000
1 ½	Stanley, 104 volts	2000
1 ½	Wagner, 104 volts, aut.	2000
1 1	Fort Wayne, 104 volts	2500
1 1	Wagner, 208 volts, aut.	2000
1 1½	Wagner, 208 volts, aut.	2000
1 5	Wagner, 104 volts, aut.	2000

SINGLE PHASE. 60 CYCLES.

H.P.		Speed.
2 ½	Phillips, 104 volts	1800
1 ½	Phillips, 208 volts	1800
3 ½	Phillips, 104 volts	1800
3 ½	Phillips, 208 volts	1800
1 1	Phillips, 208 volts	1600
1 1	Phillips, 104 volts	1600
3 1	Wagner, 208 volts	1800

H.P.		Speed.
1 3	Wagner, 208 volts	1800
1 7½	Wagner, 104 volts	1800
1 15	Wagner, 104 volts, aut.	1200
2 30	Wagner, 104 volts, aut.	1200

THREE PHASE. 125-133 CYCLES.

H.P.		Speed.
1 3	General Electric, 110 volts	1875

TWO PHASE. 60 CYCLE.

H.P.		Speed.
1 1	West., type C, 110 v.	1800
1 1	West., type C, 200 v.	1700
1 2	Gen. Elec., 220 v.	1800
1 3	Stanley, 500 v., with condenser	1860
1 7½	West., type B, 400 v.	1200
1 20	West., type C, 208 v.	1120
4 50	West., 400 v., type B.	900
1 75	West., 400 v., type B	900
2 100	West., 400 v., type B	720

THREE PHASE. 60 CYCLE.

H.P.		Speed.
2 1	Gen. Elec., 110 v.	1800
1 2	Gen. Elec., 220 v.	1800
1 3	Gen. Elec., 104 v.	1875
1 5	Gen. Elec., 110 v., type T I	1200
1 10	Gen. Elec., 110 v., form L	900
1 15	Gen. Elec., 110 v., form L	

ATTENTION, MANUFACTURERS.

Extra Slow Speed Motors, 220 volts, direct-current, suitable for operating drills, lathes, presses and tools of all descriptions electrically—these machines are all in stock and for sale cheap.

H.P.		Speed.
1 ½	Maine, M. P.	450
1 ¾	Maine, M. P.	400
4 ¾	Maine, M. P.	260
1 1	Maine, M. P.	500
1 1	Maine, M. P.	450
1 1½	Maine, M. P.	500
4 2	Maine, M. P.	260
1 3	Storey, variable speed	300-1500
1 3	Keystone, compound	650
1 3½	Eddy, M. P.	400
1 4	Commercial, M. P.	450
5 5	Western Electric, M. P.	950
1 5	Eddy, M. P.	300
3 5	Belknap, M. P.	230
1 6½	Jenney, M.P., back geared, speed of shaft	440
1 7½	Milwaukee, M. P., series, crane type, grease cup	600
1 8	Crocker-Wheeler, series, crane type	900
1 8	Maine, M. P.	200
1 10	Bernard, M. P.	170
3 10	Bernard, M. P.	130

All machines fully guaranteed.

CORLISS ENGINES AND BOILERS.

Engines

900-H.P. 34x60 International Power Corliss.
450-H.P. 16 and 30x42 Allis Compound Corliss.
450-H.P. 24x48 Brown Corliss.
400-H.P. 23x60 Geo. H. Corliss.
300-H.P. 20x48 Harris Corliss.
250-H.P. 18x48 Lane and Bodley Corliss.
225-H.P. 18x42 Hamilton Corliss.
200-H.P. 18x36 Bates Corliss.
200-H.P. 12 and 22x42 Atlas Compound Corliss.
175-H.P. 16x42 Allis Corliss.
175-H.P. 16x42 Putnam Corliss.
150-H.P. 15x38 Brown Corliss.
125-H.P. 14x36 Allis Corliss.
125-H.P. 14x36 Putnam Corliss.
100-H.P. 12x36 Harris Corliss.
85-H.P. 12x30 Lane and Bodley Corliss.
650-H.P. 28½x52 Buckeye Automatic.
450-H.P. 24x48 Buckeye Automatic.
400-H.P. 16½ and 28½x27 Buckeye Compound Aut.
250-H.P. 16 and 27x16 Westinghouse Compound.
150-H.P. 15x14 Ideal Self Oiling Automatic.
100-H.P. 13x12 Ideal Self Oiling Automatic.
90-H.P. 12x20 Atlas Side Crank Automatic.
90-H.P. 12x16 Erie Center Crank Aut.
40-H.P. 9x13 Frost Side Crank Automatic.

Boilers

1—350-H.P. Babcock and Wilcox Boiler, 150 lbs.
1—280-H.P. Babcock and Wilcox Boiler, 150 lbs.
2—265-H.P. Babcock and Wilcox Boilers, 150 lbs.
3—265-H.P. Babcock and Wilcox Boilers, 135 lbs.
1—175-H.P. Babcock and Wilcox Boiler, 125 lbs.
1—172-H.P. Babcock and Wilcox Boiler, 130 lbs.
1—250-H.P. Cahall Vertical Boiler, 160 lbs.
1—72x18 Tubular Boiler, 130 lbs.
1—72x18 Tubular Boiler, 125 lbs.
7—72x18 Tubular Boilers, 100 lbs.
3—72x16 Tubular Boilers, 100 lbs.
8—66x18 Tubular Boilers, 100 lbs.
3—66x16 Tubular Boilers, 100 lbs.
1—60x18 Tubular Boiler, 100 lbs.
4—60x16 Tubular Boilers, 100 lbs.
2—60x14 Tubular Boilers, 120 lbs.
Wainright Heaters 50, 75, 100, 150 and 200-H.P.

WHITEHEAD MACHINERY COMPANY, - - - Davenport, Iowa.

FOR SALE.

DIRECT CONNECTED.

30-K.W. Eddy dynamo to Watertown engine, 110 volts.
10-K.W. Westinghouse dynamo to Armington & Sims engine, 110 volts.
10-K.W. Westinghouse dynamo to Westinghouse engine, 110 volts.
80-Amp. Edison dynamo to Brotherhood engine, 80 volts.
20-H.P. Elektron 220 volt motor to Morse Williams freight elevator.

BELTED.

60-amp. Crocker-Wheeler to Herresoff engine, 110 volts.
2000 volt Electro Dynamic arc dynamo, 10 amperes.
500-Lt. Edison dynamo, 110 volts.
60-amp. Westinghouse dynamo to Westinghouse engine, 110 volts.
35-amp. Sprague dynamo to Hornby Ackroyd oil engine.
600-Lt. Weston dynamo, 110 volts.
500-Lt. Edison Dynamo, 110 volts, D.C. to Brotherhood engine.
400-Lt. Excelsior dynamo, 110 volts.
45-H.P. C. & C. motor, 230 volts.
30-H.P. C. & C. motor, 230 volts.
15-H.P. Thomson-Houston motor, 500 volts, with spare armature.
15 General Electric, 2-H.P., 220 volt motors.
12 Siemens & Halske 5-H.P., 220 volt motors, 220 volts, 1550 R.P.M.
2 search lights.
These motors are dust proof and series wound.
Large stock of smaller dynamos and motors.
Repairing of electrical machinery in all its branches.

JORDAN BROS., 74 Beekman St., N. Y.

LOUIS HECK,

Successor to STUCKY & HECK, ELECTRICAL MANUFACTURING CO., Lit'd.

Electrical and Mechanical Engineers and Draughtsman

Every System—Repairing, Re-winding, Re-construction

Telephone No. 977

35 N. J. RAILROAD AVE., Opp. Market St. Railroad Depot, NEWARK, N. J.

STATION EQUIPMENT COMPANY

204 Dearborn Street
CHICAGO, ILL.

100-K.W., General Electric, 125-V., M.P. generator, direct connected to 15½ x 16 New York Safety automatic engine.
100-K.W., Western Electric, 115-V., M.P. generator, direct connected to 16 x 16 latest type Ideal engine.
100-K.W., 125-V., Edison bi-polars.
150-K.W., 220-V., Edison bi-polars.
75-K.W., 220-V., Western Electric M.P.
120-K.W. General Electric alternators.
20 x 42 heavy-duty Allis Corliss engine.
24 x 48 Allis Corliss engine.
500-H.P., cross-compound, condensing engine, 150 lbs. steam.

Write for our new stock list, No. 42, of Station Equipments and Accessories.

FOR SALE

Complete new apparatus embodying all the most recent improvements in machinery employed in the manufacture of incandescent electric lamps. Will guarantee lamp manufacturers results as to cost and quality. Address No. 1158, care Electrical World and Engineer, New York.

FOR SALE

Electric light plant in town of 1,000 population. In fine shape and on sound financial basis. I did not want to take it, but was obliged to and now want to sell it. New generator and thoroughly overhauled since taking possession. E. E. Secor, Buffalo Center, Iowa.

FOR SALE

Electric light plant in city of 10,000 inhabitants. About 6,000 lights wired up. Will sell cheap to quick purchaser. Address No. 1277, care Electrical World and Engineer, New York.

WANTED

SOUTH AMERICAN AGENCY

Reliable party resident in South America desires to represent or act as selling agent for manufacturing or export firms. Address A. M., 122 Front Street, New York.

FOR SALE

DIRECT CONNECTED ENGINES AND GENERATORS. Two 42-K.W. Westinghouse 240-volt machines to 12x12 Alfree automatic engines; perfect condition; immediate delivery; low price. JOHN W. COLE, PROVIDENCE, R. I.

WANTED

500-H.P. simple compound Corliss engine, 300-K.W., 2200 volts, single phase alternator, 125 cycles; give dimensions and full description of above with price, and state where can be inspected. ASTORIA ELECTRIC CO., Astoria, Oregon.

FOR SALE

Immediate delivery. 70-K.W., 250 volts, 600 R.P.M. 4 pole Type G, self-oiling Eddy dynamo, one of their latest and best machines in thorough repair Commutator never turned. Price $600.00. J. L. Gleason & Co., 143 Federal St., Boston, Mass.

FOR SALE

La Lumiere Electrique, Paris

A set nearly complete. This set lacks only 13 numbers and 3 vols. of a complete set which consists of 53 vols. 22 vols. are bound in half red morroco, others in parts. The missing vols. are 19, 40 and 52. A complete set sells for $100.00. The price of this set is $65.00.

Mechanics' Magazine, London

A complete set from vol. 1, No. 1, Aug. 30, 1823, to the end of vol. 69, Nov. 27, 1858. 69 vols. bound in boards, some covers loose, $40.00.

The Physical Review. A complete set

from the commencement to Dec., 1903, 17 vols. unbound, in very clean condition, mostly uncut, $35.00.

American Society of Civil Engineers

A complete set of the *Transactions* and *Proceedings* from the commencement to Dec., 1896, consisting of the *Transactions*, vols. 1 to 36, and the *Proceedings*, vols. 1 to 22 complete, unbound, with two general indexes to the *Transactions*, vols. 1 to 21 and vols. 22 to 27. $125.00.

Municipal Journal and Engineer. A complete set

including its predecessor, City Government, from vol. 1, No. 1, Aug., 1896, to vol. 15, No. 6, Dec., 1903. Vols. 1, 2 and 3 bound in cloth in one vol. Others unbound. $30.00.

For offers of other sets see adv. in ELECTRICAL WORLD AND ENGINEER, Oct. 24 and 31.

EDWARD CALDWELL, - 112 Liberty St., New York

STOP LOOK LISTEN

WE BUY FOR YOU. WE SELL FOR YOU.

Second-hand electrical equipment, steam engines, etc. anywhere in the United States. We want nothing unless fully guaranteed. Write us for full information. Complete central station equipment our specialty.

BEARDSWORTH ENG. & MACH. CO.,
313 ELECTRIC BLDG. CLEVELAND, O

MATERIALS FOR THE

PERMANENT INSULATION OF ELECTRIC COILS

(1) DIELECTRIC MNFG. CO., SAINT LOUIS

FOR SALE

NEW AMERICAN INVENTION

Four-Party Selective Signaling Telephone System, Great Improvement, Being installed extensively in the U. S. American Patent allowed. Parties desiring to secure foreign patents will be furnished with copies, details and rights from the inventor for $150. Guaranteed as represented by a reliable concern. American made goods supplied if desired. Address No. 1252, care Electrical World and Engineer, New York.

Free Sample

HART & CO.

MONADNOCK, BLDG. CHICAGO

PROPOSALS will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until 12 o'clock noon, February 23, 1904, and publicly opened immediately thereafter, to furnish at the navy yards, Mare Island, Cal., and Puget Sound, Wash., a quantity of lighting wire, electrical supplies, hand scrub brushes, corn brooms, Portland cement, cotton twine, curled hair, mattress ticking, linen, furniture, belting, white ash, pine, redwood, thimbles, files, hardware, machine tools, galvanized sheet steel, magnesia, rubber sheet packing, hose, alcohol, turpentine, brass pipe, wrought-iron pipe, pipe fittings, rubber coupling washers, baseballs, athletic goods, stationery and cotton waste. Blank proposals will be furnished upon application to the navy pay offices, San Francisco, Cal., and Seattle, Wash. H. T. B. HARRIS, *Paymaster General, U. S. N.* 1-18-04

FOR SALE

Electric supply and construction business in an Ohio City of 15,000. $200.00 worth of tools and store fixtures, $500.00 worth of stock, over $1,000.00 in contracts closed. Address No. 1298, care Electrical World and Engineer, New York.

WANTED

To purchase an interest in an established electrical supply or repair business or central station. Address, with full details, No. 1291 Electrical World and Engineer, New York.

POSITIONS WANTED.

(*Continued from page 84.*)

POSITION WANTED.—Desire to correspond with parties who are either already engaged in the electrical and mechanical engineering business who wish to engage the services of an up-to-date expert in this line, or parties with capital desiring to engage in this business, but lack the necessary expert technical and practical knowledge to insure success; the designing of steam driven electric power transmission power plants a specialty; gilt edge references. Address A. W. Morrell, South Bend, Indiana.

POSITION WANTED.—Where ability and study of employer's interest will be rewarded with advancement, by technical graduate in electrical engineering, with eight years' experience in operation of electric lighting and street railway business; able to take charge of commercial side of either; salary at start no object with right concern; references by present employers; married and of good address. Address No. 1284, care Electrical World and Engineer, New York.

(*Continued on page 87.*)